

**FINAL**

**PHASE I RFI/RI WORK PLAN**

**ROCKY FLATS PLANT  
100 AREA  
(OPERABLE UNIT NO. 13)**

**U.S. DEPARTMENT OF ENERGY  
Rocky Flats Plant  
Golden, Colorado**

**ENVIRONMENTAL RESTORATION PROGRAM**

**OCTOBER 9, 1992**

**Volume I of III  
Text**

**ADMIN RECORD**

A-OU13-000029

REVIEWED FOR CLASSIFICATION/UCM  
By [Signature]  
Date 10/21/92 [Signature]

**INTEROFFICE CORRESPONDENCE**

DATE: March 6, 1992

TO: P. L. Fuller, Remediation Programs Division, Bldg. T130B, X5744

FROM: R. B. Hoffman, Classification Office, T893B, X4598 *SLC G. RBH*

SUBJECT: CLASSIFICATION EXEMPTION WAIVER FOR REMEDIATION PROGRAMS DIVISION (RPD) DOCUMENTS

Your request for exemption from classification/UCNI review of Remediation Programs Division (RPD) documents as proposed in your letter of March 5, 1992 has been considered.

Based upon a substantial historical perspective, we have concluded that the reporting activities in which your Division of the Environmental Management Department is involved are unclassified and UCNI-free in nature and content.

All reporting activities for those Operable Units (OUs) one thru sixteen, except, Operable Unit 15 - Inside Building Closures, can be considered as exempt from further classification/UCNI review by the Classification Office. This waiver includes internal, as well as, external letters, work plans, reports, interim measures, RCRA facilities investigations, interim remedial actions, site characterization studies, human health risk assessments, environmental evaluations and assessments, comparative analyses, and other environmental and administrative documentation, as outlined in your letter. At this time sufficient knowledge of the type of information which OU 15 will comprise has not been established and until this can be ascertained, classification review will be necessary.

In general, should RPD documents begin to differ in scope and context from past practice, it will become mandatory that you contact this office to ensure that this classification review waiver be justified and correct.

Should you require any further information or have any questions regarding this matter, please feel free to contact me or Karl Dallarosa (X3792) at any time.

kld

cc:  
P. S. Bunge  
J. E. Evered  
W. A. Hunt

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By K. L. [signature]

Date 10/21/92 (MNS)

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## LIST OF ACRONYMS

AEC	U.S. Atomic Energy Commission
AIP	Agreement in Principle
APEN	Air Pollution Emissions Notice
ARAR	Applicable or Relevant and Appropriate Requirement
ASI	Advanced Sciences, Inc.
BRA	Baseline Risk Assessment
BRAP	Baseline Risk Assessment Plan
CA	Controlled Area
CAD	Corrective Action Decision
CDH	Colorado Department of Health
CEARP	Comprehensive Environmental Assessment and Response Program
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
CMS	Corrective Measures Study
COC	Contaminants of Concern
CPS	Cancer Potency Slopes
CWAD	Clean Water Act Division
DCA	Dichloroethane
DCE	Dichloroethene
DCG	Derived Concentration Guide
DOE	U.S. Department of Energy
DRCOG	Denver Regional Council of Governments
DQO	Data Quality Objective
EE	Environmental Evaluation
EEWP	Environmental Evaluation Work Plan
EG&G	EG&G Rocky Flats, Inc.
EIS	Environmental Impact Statement
EMD	Environmental Management Division
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration
ERDA	Energy Research and Development Administration
ERP	Environmental Restoration Program
FFCA	Federal Facilities Compliance Act
FS	Feasibility Study
FSAP	Field Sampling and Analysis Plan
FSP	Field Sampling Plan
GC	Gas Chromatograph
GC/MS	Gas Chromatograph/Mass Spectrometer
GRRASP	General Radiochemistry and Routine Analytical Services Protocol
HEAST	Health Effects Assessment Summary Tables

## LIST OF ACRONYMS - Continued

HSL	Hazardous Substance List
HRR	Historical Release Report
IAG	Interagency Agreement
IARC	International Agency for Research on Cancer
IHSS	Individual Hazardous Substance Site
IRIS	Integrated Risk Information System
LWA	Lee Wan & Associates
MEK	Methyl Ethyl Ketone
MetSta	Meteorological Station
MSL	Mean Sea Level
NCP	National Contingency Plan
NEPA	National Environmental Policy Act
NPDES	National Pollutant Discharge Elimination Act
OPWL	Original Process Waste Line
OU	Operable Unit
PA	Protected Area
PAH	Polycyclic Aromatic Hydrocarbon
PARCC	Precision, Accuracy, Representativeness, Completeness, and Comparability
PCE	Tetrachloroethene
PM	Particulate Matter
PSZ	Perimeter Secured Zone
PU&D	Property Utilization and Disposal
PWL	Process Waste Lines
QA	Quality Assurance
QAA	Quality Assurance Addendum
QAPjP	Quality Assurance Project Plan
QC	Quality Control
RAS	Routine Analytical Services
RCRA	Resource Conservation and Recovery Act
RfD	Risk Reference Dose
RFEDS	Rocky Flats Environmental Database System
RFI	RCRA Facility Investigation
RFP	Rocky Flats Plant
RI	Remedial Investigation
ROD	Record of Decision
SID	South Interceptor Ditch
SSH&SP	Site Specific Health and Safety Plan
STP	Sewage Treatment Plant
SWD	Surface Water Division
SWMU	Solid Waste Management Unit
TCA	Trichloroethane
TCE	Trichloroethylene



## LIST OF ACRONYMS - Continued

TLL- $\alpha$	Total Long-Lived Alpha
TSP	Total Suspended Particulates
UBC	Under Building Area of Concern
USGS	United States Geological Survey
VOC	Volatile Organic Compound
WQCC	Water Quality Control Commission
WWE	Wright Water Engineers, Inc.

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1 of 6

TITLE: Executive Summary

Approved By:

02/01/93  
Effective Date

Michael J. Fairlie Hoyle  
Manager

10/9/92  
Date

## EXECUTIVE SUMMARY

This document presents the Work Plan for the Phase I Resource Conservation and Recovery Act (RCRA) Facility Investigation/Remedial Investigation (RFI/RI) for Operable Unit No. 13 (OU13) at the U.S. Department of Energy (DOE) Rocky Flats Plant (RFP) in Jefferson County, Colorado. The Work Plan was prepared to satisfy the requirements of the Interagency Agreement (IAG) of January 22, 1991. OU13 was originally configured by Individual Hazardous Substance Sites (IHSSs) located immediately south of the west end of the Protected Area (PA). The IHSSs are potentially contaminated areas that have been identified based on previous investigations and historical accounts of site usage. The Phase I RFI/RI Investigation of OU13 will examine the suspected relationship of the IHSSs to soil and groundwater contamination at the site. OU13 IHSSs consist of the following:

- The North Chemical Storage Site (IHSS 117.1) is located north of the intersection of Sage Avenue and Seventh Street. Past use of the site included storage of building construction debris, other nonradioactive waste, and scrap metal. Automotive batteries may have been included in the stored materials. No chemicals were stored at this site.
- The Middle Chemical Storage Site (IHSS 117.2) is located south of IHSS 117.1, south of Sage Avenue and west of Seventh Street. It is east of the northern part of Building 551. The area was used as a multi-purpose storage facility including warehouse storage, nonradioactive chemical storage, and storage for pallets, cargo containers, and new drums. It is still used as a storage area.
- The South Chemical Storage Site (IHSS 117.3) is located south of IHSS 117.2, south of Central Avenue and west of Seventh Street. It was used for storage of various unidentified material from at least 1964, or earlier, until 1970. About four gallons of radioactively contaminated oil was reported to have leaked from a

waste box that was transferred to the site in 1965. The contaminated ground was immediately removed. A large fuel oil storage tank (Tank 224) was constructed in the area in 1973.

- The Oil Burn Pit No. 1 Waste Leak (IHSS 128) is located north of building 335 and beneath Sage Avenue, east of the Fourth Street intersection. It is the site of the reported disposal of about 200 gallons of contaminated (depleted uranium) waste oils by burning in a pit in 1956. The pit was backfilled after the oil was burned. The area is now almost entirely covered by Sage Avenue, which was constructed in 1969 and 1970.
- The Lithium Metal Destruction Site (IHSS 134) is located in an area that extends from the location of IHSS 128 southward to the eastern wing of Building 331. Waste lithium was destroyed in this area by burning oil and lithium in 55-gallon drums. The residue containing oxidized lithium was probably sent to the Original Landfill (IHSS 115). The approximate duration of these activities was 1963 to 1966.
- The Waste Spills (IHSS 148) is located at Building 123, west of Fourth Street between Central and Cottonwood Avenues. It is a result of reported small spills of nitrate-bearing wastes around the outside of Building 123 and possible leakage of original process waste lines beneath the building, which were abandoned about 1975. The wastes may have contained radionuclides.
- The Fuel Oil Tank 221 Spills site (IHSS 152) is located west of Seventh Street, between Central and Cottonwood Avenues east of Building 452. The spills are associated with an 800,000-gallon fuel oil storage tank. The tank was constructed in 1973 and fuel oil leaks have occurred there.
- The North Area Radioactive Site (IHSS 157.1) is located at Building 442, southwest of the intersection of Central Avenue and Fifth Street. Building 442 was used as a laundry from 1952 until about 1972, when it was converted to a filter test laboratory. The laundry received contaminated clothing and rags, which contained uranium and possibly beryllium. An example of potential contamination is leakage from a barrel of contaminated rags stored outside of the building.
- The Building 551 Radioactive Site (IHSS 158) is beneath the north wing of Building 551, and includes Building 554 which was the train loading facility. The area is potentially contaminated from leakage of radioactive materials from containers stored and loaded there.

- The Waste Peroxide Drum Burial (IHSS 169) was reported to have occurred in the chemical storage area east of Building 551. This event probably did not occur. Instead, it appears to be a result of confusion with IHSS 191 (Hydrogen Peroxide Spill). Documentation is presented in this Work Plan to support a no further action justification by the agencies in the record of decision.
- The Solvent Burning Ground (IHSS 171) is located near building 335. The yard to the east of the building has been used to practice extinguishing fires since 1969. Diesel fuel, gasoline, propane, and possibly solvents have been ignited in metal pans. Some of this material may have spilled onto the ground.
- The Valve Vault 12 (IHSS 186) is located north of Sage Avenue, northwest of Building 552. It is a part of the existing process waste system. Process waste may contain a large range of constituents, including uranium, americium, and plutonium. In 1986 a leak was detected in a process waste line west of Valve Vault 12. The leak was cleaned up by removing contaminated soil.
- The Caustic Leak (IHSS 190) involved a leak of raw (not waste) sodium hydroxide from an above-ground, 3,000-gallon tank located east of Building 443. The sodium hydroxide entered the Central Avenue Ditch. Alum was used to neutralize water in the ditch.
- The Hydrogen Peroxide Spill (IHSS 191) occurred in 1981, when a drum of raw (not waste) hydrogen peroxide burst after it fell from a pallet being transported by warehouse personnel. The spill occurred near the corner of Fifth Street and Central Avenue. The spill was diluted with water.

The general setting of these spills and leaks includes an industrial area that has been gradually developed. The natural soils have been disturbed, replaced by fill, or covered by pavement and structures. The soils, fill, pavement, and structures are underlain by Rocky Flats Alluvium except where the alluvium has been excavated to bedrock and replaced by fill. The Rocky Flats Alluvium in the OU13 area varies in thickness to about 38 feet and is composed of poorly- to moderately-sorted clay, silt, sand, and gravel. The Cretaceous Arapahoe Formation underlies the surficial material. It is mainly claystone and silty claystone with sandstone bodies present. Recent mapping suggests that the Arapahoe is generally less than 50 feet thick. The Arapahoe is underlain by an upper claystone unit of the Laramie Formation. These bedrock units dip

gently to the east. The unconformity between the Arapahoe Formation and the Rocky Flats alluvium is a pediment surface that contains paleotopographic highs and lows of the pre-Rocky Flats Alluvium drainage system.

The water table is generally within the alluvium in the OU13 area, but may approach or pass beneath the bedrock boundary at certain places during dry seasons. Groundwater flow beneath OU13 is generally eastward, but local deviations may occur due to the effect of bedrock paleotopography during dry seasons and due to the effect of lenticular sandstones in the Arapahoe Formation. The alluvium is more permeable than the bedrock. Consequently, the groundwater tends to flow through the more permeable surficial material above the contact with the less permeable Arapahoe Formation.

Since the IHSSs involve spills and leaks that enter the subsurface, the conceptual models of contaminant migration involve percolation downward through the vadose zone (generally less than 10 feet thick) to the water table and then in the direction of groundwater flow. Contaminants may be lost during transit due to volatilization (which may release contaminants to the atmosphere), biodegradation, and radioactive decay. Contaminants may be immobilized by chemical precipitation and retarded by adsorption. Contaminant concentrations are reduced by dispersion as they move through the porous media. Mobile contaminants carried by the groundwater may eventually reach the ground surface and surface water at such discharge points as seeps, springs, and gaining reaches of nearby streams. Eroded surficial material from OU13 may enter ditches and eventually reach detention ponds.

The field sampling and analysis plan is designed to meet the Data Quality Objectives (DQOs). The rationale for the sampling is based on a staged approach. Stage 1 will address the presence of contamination and will involve primarily screening level surveys. Stage 2 will confirm the

results of Stage I and verify the presence of contamination in the vadose zone and groundwater. Stage 3, if necessary, will address the extent of contamination and the potential migration of contaminants from each IHSS.

Types of activities to be conducted during Stage 1 include surface radiation surveys, soil gas surveys, groundwater sampling from existing wells and piezometers, and limited surficial soils analysis. Activities to be conducted under Stage 2 include borehole sampling, surface scrape sampling, and groundwater sampling. Upon completion of Stage 2, all data collected will be evaluated to determine whether further investigation of each IHSS is required.

The Field Sampling and Analysis Plan presents detailed procedures for each IHSS for Stage 1 and Stage 2 sampling. Stage 2 will consist of drilling one to three boreholes at locations indicated by Stage I sampling. As the borehole is being drilled at the location of the highest level of contamination detected in Stage 1 surveys at the IHSS, groundwater samples will be collected. Hydropunch®, or equivalent, technology will be used to collect the groundwater samples. For scoping purposes, it is assumed that two alluvial groundwater monitoring wells will be required in Stage 3 at each IHSS determined to be a source of contamination in Stages 1 and 2. One monitoring well will be located up-gradient and one down-gradient.

Lists of compounds to be analyzed for at each stage of the investigation are based upon the requirements of the IAG and on historical data obtained during the preparation of this Work Plan.

The data collected during the field sampling and analysis will be used for site characterization and risk assessment. The Human Health Risk Assessment considers risks from both radiological and non-radiological contaminants. Source related contaminants present at IHSSs will be evaluated to identify Contaminants of Concern. Adequate documentation will be prepared to justify including or excluding specific contaminants. An exposure assessment will be performed

that will identify exposure pathways, potentially exposed populations, and the dynamics of the population exposures. A toxicity assessment will describe the contaminants relative to their potential to cause harm. Risk characterization will involve exposure assumptions and toxicity information to quantitatively estimate the risk of adverse health effects. Uncertainties in the risk assessment procedure will be identified and the reliability of the risk assessment will be evaluated.

The OU 13 Environmental Evaluation (EE) will be coordinated with OU9 and OU6 evaluations due to overlapping of study areas. OU9, the Original Process Lines network that extends throughout much of the production area, will address all habitat description necessary within the industrial area. The OU9 EE Work Plan defines an ecological risk assessment within the production study area. Areas of concern in OU13 which bridge the boundary between the RFP site buffer zone and the production area are incorporated in OU6.

The Quality Assurance Addendum (QAA) to this Work Plan provides detailed procedures for the conduct of the work including training; sampling; logging; analytical procedures; equipment control and decontamination; air monitoring; data reduction, validation, and reporting; control of documents, items, samples, and data; control of sampling and analysis processes; corrective action; and maintenance of quality assurance records.

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## 1.0 INTRODUCTION

This document presents the Work Plan for the Phase I Resource Conservation and Recovery Act (RCRA) Facility Investigation/Remedial Investigation (RFI/RI) for Operable Unit No. 13 (OU13) at the U.S. Department of Energy (DOE) Rocky Flats Plant (the RFP) in Jefferson County, Colorado. Volume I of this RFI/RI contains the text. Volumes II and III contain Appendices.

This investigation is part of a comprehensive, phased program of site characterization, remedial investigations, feasibility studies (FSs), and remedial/corrective actions currently in progress at the RFP. These investigations are pursuant to an Interagency Agreement (IAG) between DOE, the U.S. Environmental Protection Agency (EPA), and the State of Colorado Department of Health (CDH), dated January 22, 1991 (DOE, 1991a). The IAG program developed by DOE, EPA, and CDH addresses RCRA and Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) issues. In accordance with the IAG, the CERCLA terms "remedial investigation" and "feasibility study" as used in this document are considered equivalent to the RCRA terms "RCRA Facility Investigation" and "Corrective Measures Study" (CMS), respectively. Also in accordance with the IAG, the term "Individual Hazardous Substance Site" (IHSS) is equivalent to the term "Solid Waste Management Unit" (SWMU).

### 1.1 ENVIRONMENTAL RESTORATION PROGRAM

The Environmental Restoration (ER) Program, designed for investigation and cleanup of environmentally contaminated sites at DOE facilities, is being implemented in five phases.



Phase 1 (Installation Assessment) includes preliminary assessments and site inspections to assess potential environmental concerns. Phase 2 (RIs) includes planning and implementation of sampling programs to delineate the nature and extent of contamination at specific sites and evaluate potential contaminant migration pathways. Phase 3 (FSs) includes evaluation of remedial alternatives and development of remedial action plans to mitigate environmental problems identified in Phase 2. Phase 4 (Remedial Design/Remedial Action) includes design and implementation of site-specific remedial actions selected on the basis of Phase 3 feasibility studies. Phase 5 (Compliance and Verification) includes monitoring and performance assessments of remedial actions as well as verification and documentation of the adequacy of remedial actions carried out under Phase 4. Phase 1 of the ER Program has been completed at the RFP (DOE, 1986), and Phase 2 is currently in progress. This Work Plan for a "Phase I RFI/RI" is part of Phase 2 of the ER Program.

## 1.2 WORK PLAN SCOPE

As required by the IAG, this Work Plan addresses characterization of sources and environmental media at each IHSS in OU13. It also addresses the nature and extent of contamination at each IHSS, migration pathways, and receptor exposure.

In this Work Plan, the existing information is summarized to characterize OU13, data gaps are identified, Data Quality Objectives (DQOs) are established, and a Field Sampling and Analysis Plan (FSAP) is presented to characterize site physical features, define contaminant sources, and assess the extent of contamination.

The Work Plan is for Phase I RFI/RI. It will be conducted in accordance with the Interim Final RCRA Facility Investigation (RFI) Guidance (EPA, 1989a) and Guidance for Conducting

Remedial Investigations and Feasibility Studies Under CERCLA (EPA, 1988a). Existing data and that generated by the Phase I RFI/RI will be used to begin developing and screening remedial alternatives and to estimate the risks to human health and the environment posed by sources within OU13.

This Work Plan is organized as follows:

- Section 1.0 of this Work Plan provides introductory information and a general characterization of the RFP regional and plant-site background information. This includes a description of the Work Plan Scope and Overview.
- Section 2.0 presents a comprehensive review and detailed analysis of all available historical information, previous site investigations, recently published reports, available data, and past and present activities pertinent to OU13. Included in Section 2.0 are characterization results for site geology and hydrology as well as the known nature and extent of contamination in soils, groundwater, surface water, and sediments. Additionally, Section 2.0 presents conceptual models of sites where hazardous substances may have been released based on the physical characteristics of the sites and available information regarding the nature and extent of contamination.
- Section 3.0 presents a preliminary identification of Applicable or Relevant and Appropriate Requirements (ARARs) and their application to OU13.
- Section 4.0 outlines Phase I RFI/RI tasks to be performed.
- Section 5.0 establishes data needs and DQOs considering the site characteristics and conceptual model provided in Section 2.0.
- Section 6.0 presents the FSAP for the Phase I RFI/RI to satisfy the data needs and DQOs outlined in Section 5.0
- Section 7.0 presents a preliminary schedule for implementation of the Phase I RFI/RI.

- Sections 8.0 and 9.0 provide the Human Health Risk Assessment Plan and the Environmental Evaluation Work Plan components of the Phase I Baseline Risk Assessment Plan, respectively.
- Section 10.0 describes the Quality Assurance Addendum.
- Section 11.0 provides a list of references.

Additionally, the appendices contain all available supporting data used to characterize the physical setting and contamination at OU13.

### 1.3 REGIONAL AND PLANT-SITE BACKGROUND INFORMATION

#### 1.3.1 Facility Background

The RFP is a government-owned, contractor-operated facility, which is part of the nationwide Nuclear Weapons Complex. It was operated for the U.S. Atomic Energy Commission (AEC) from its inception in 1951 until the AEC was dissolved in January 1975. At that time, responsibility for the RFP was assigned to the Energy Research and Development Administration (ERDA), which was succeeded by DOE in 1977. Dow Chemical U.S.A., an operating unit of the Dow Chemical Company, was the prime operating contractor of the RFP from 1951 until June 30, 1975. Rockwell International was the prime contractor responsible for operating the RFP from July 1, 1975 until December 31, 1989. EG&G Rocky Flats, Inc. became the prime contractor at the RFP on January 1, 1990.

### 1.3.2 Plant Operations

Historic operations at the RFP consisted of fabrication of nuclear weapons components from plutonium, uranium, and other nonradioactive metals (principally beryllium and stainless steel). Parts made at the RFP were shipped elsewhere for assembly. In addition, Rocky Flats also reprocessed components after they were removed from obsolete weapons for recovery of plutonium. Other activities at the RFP included research and development in metallurgy, machining, nondestructive testing, coatings, remote engineering, chemistry, and physics. Both radioactive and nonradioactive wastes were generated in the production process. Plutonium operations were suspended in November, 1989. In January, 1992, the Secretary of Energy indicated that Rocky Flats would no longer be regarded as a production facility and its new mission would be environmental restoration, decontamination and decommissioning. Only limited non-nuclear production would continue through FY 1993. Current waste handling practices involve onsite and offsite recycling of hazardous materials, onsite storage of hazardous and radioactive mixed wastes, and offsite disposal of solid radioactive materials at another DOE facility. However, the RFP operating procedures historically included both onsite storage and disposal of hazardous, radioactive, and mixed wastes (a mixture of hazardous wastes and mixed wastes). Preliminary assessments under the ER Program identified some of the past onsite storage and disposal locations as potential sources of environmental contamination.

### 1.3.3 Previous Investigations

Various studies have been conducted at the RFP to characterize environmental media and to assess the extent of radiological and chemical contaminant releases to the environment. The investigations performed prior to 1986 are summarized in Rockwell International (Rockwell, 1986a) and include:

- Detailed descriptions of the regional geology (Malde, 1955; Spencer, 1961; Scott, 1960, 1963, 1970, 1972, and 1975; Van Horn, 1972 and 1976; Dames and Moore, 1981; and Robson, et al., 1981a and 1981b).
- Several drilling programs beginning in 1960 that resulted in the construction of approximately 60 groundwater monitoring wells by 1982.
- An investigation of surface- and groundwater-flow systems by the U.S. Geological Survey (Hurr, 1976).
- Environmental, ecological, and public health studies which culminated in an environmental impact statement (DOE, 1980).
- A summary report on groundwater hydrology using data from 1960 to 1985 (Hydro-Search, Inc., 1985).
- A preliminary electromagnetic survey of the RFP perimeter (Hydro-Search, Inc. 1986).
- A soil gas survey of the RFP perimeter and buffer zone (Tracer Research, Inc., 1986).
- Routine environmental monitoring programs addressing air, surface water, groundwater, and soils. These programs are summarized in the annual environmental monitoring reports (Rockwell, 1975 through 1983a, 1984, 1985, and 1986b).

Additional information on routine environmental programs is also presented in post-1986 annual environmental monitoring reports (Rockwell, 1987a, 1989a, and EG&G, 1990a).

In 1986, two major investigations were completed at the RFP. The first was the ER Program Phase I Installation Assessment (DOE, 1986) which included analyses and identification of current operational activities, active and inactive waste sites, current and past waste management practices, and potential environmental pathways through which contaminants could be transported. A number of sites were identified that could potentially have adverse impacts on

the environment. These sites were designated SWMUs by Rockwell International (Rockwell, 1987b) and were divided into three categories:

- 1) Hazardous waste management units that will continue to operate and need a RCRA operating permit;
- 2) Hazardous waste management units that will be closed under RCRA interim status; and
- 3) Inactive waste management units that will be investigated and cleaned up under Section 3004(u) of RCRA or CERCLA (Sec. 107).

The IAG redefines the SWMUs within the second and third categories as IHSSs. The term IHSS is used hereinafter; however, no RCRA or CERCLA regulatory distinction in the use of the terms "site", "unit", or "IHSS" is intended in this document.

Recent investigations have included a background geochemical investigation (EG&G, 1990d), geologic characterization (EG&G, 1991c), and surface geologic mapping (1992f). A recent background geochemical characterization plan (EG&G, 1992g) describes a plan for continued collection, screening, and statistical analysis of background data.

#### 1.3.4 Physical Setting

##### 1.3.4.1 Location

The RFP is located in Section 1 through 4, and 9 through 15, of Township 2 South, Range 70 West of the 6th Principal Meridian, in northern Jefferson County, Colorado, approximately 16 miles northwest of Denver (Figure 1-1). Nearby cities include Boulder, 12 miles to the north, Westminster, 7 miles east, and Arvada, 5 miles southeast. The cities of Golden and Lakewood

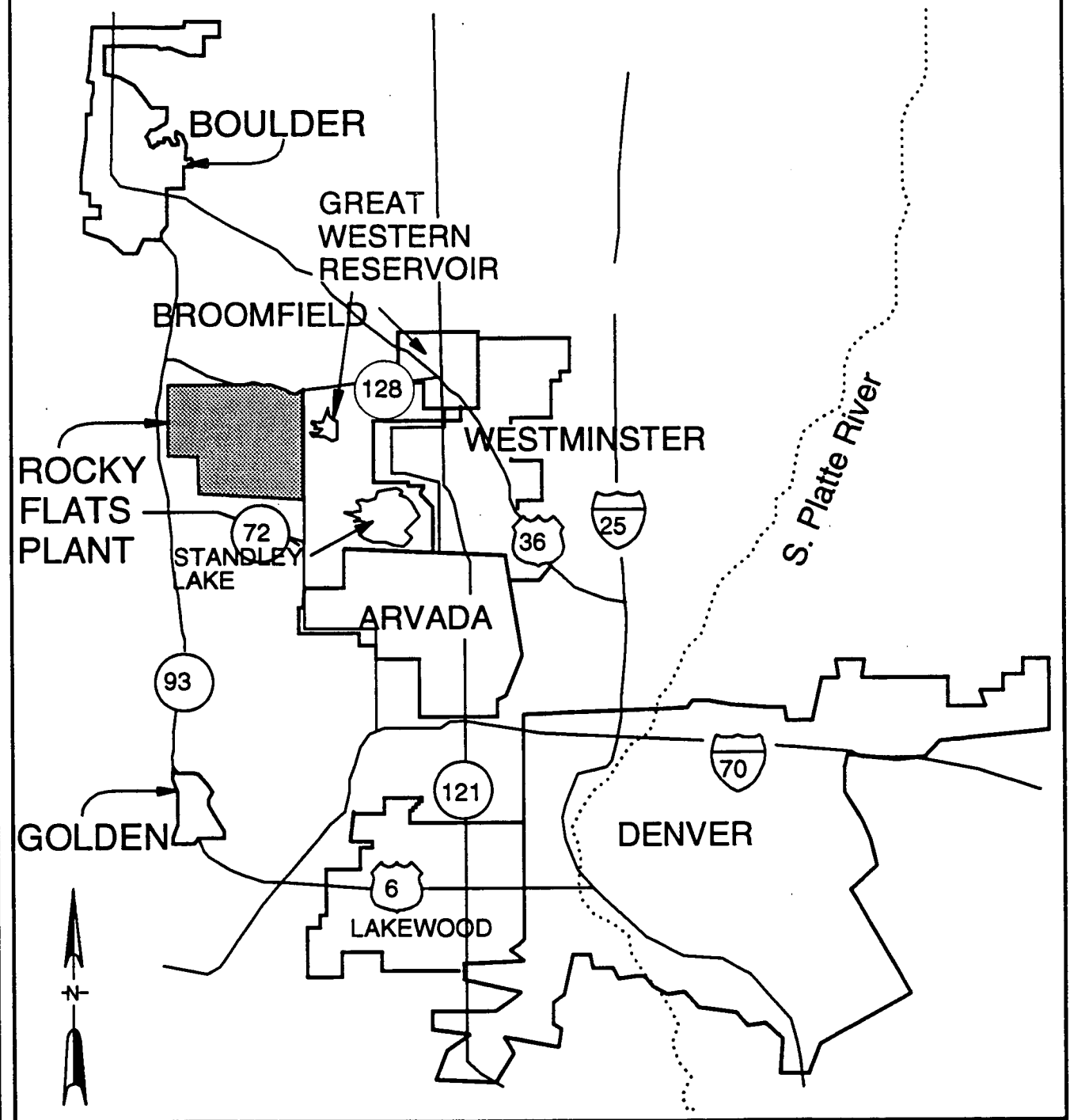


FIGURE 1-1

SITE LOCATION MAP - ROCKY FLATS PLANT

OPERABLE UNIT NO.13  
PHASE I RFVRI WORK PLAN

U.S. DEPARTMENT OF ENERGY  
Rocky Flats Plant, Golden, Colorado

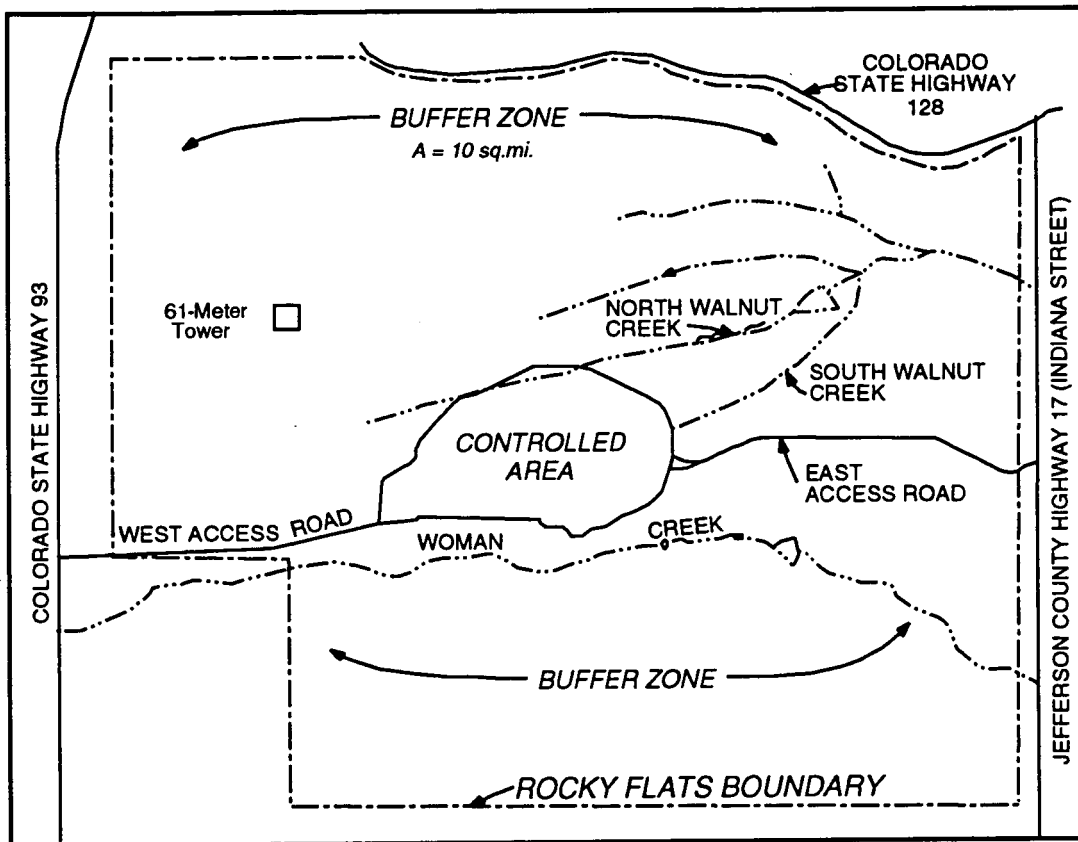
are located approximately 15 miles directly south of the RFP. The RFP property consists of approximately 6,550 acres of federally-owned land, 400 acres of which is located within the RFP security area (Controlled Area) where most major buildings are located. The Controlled Area (CA) is surrounded by a buffer zone of approximately 6,150 acres (Figure 1-2). The northern boundary of the property sits on the county line between Jefferson County and Boulder County. The property is bordered on the north by Colorado Highway 128, on the east by Jefferson County Highway 17 (Indiana Street), on the south by agricultural and industrial properties and Highway 72, and on the west by State Highway 93. Access to the property is via Colorado Highway 93 or Indiana Street.

OU13 is located in the center of the RFP. A finger-like section containing a portion of IHSS 190 extends from the main section of OU13 to the east and northeast and reaches the eastern edge of the RFP. This finger-like portion represents the surface drainage pathway of IHSS 190, a caustic spill which occurred in December of 1978.

#### 1.3.4.2 Topography

The RFP is located along the eastern edge of the southern Rocky Mountain region immediately east of the Colorado Front Range. The RFP is at an average elevation of approximately 5,950 feet above mean sea level (MSL). The site is located on a broad, eastward-sloping alluvial surface. The surface of the alluvium is nearly flat but slopes gently eastward at 95 feet per mile (EG&G,1991a). At the RFP, the alluvial surface is dissected by a series of east-northeast trending stream-cut valleys. The valleys containing Rock Creek, North and South Walnut Creeks, and Woman Creek are cut 50 to 200 feet below the level of the older alluvial surface in the vicinity of the RFP.





0 2,000 4,000  
 APPROXIMATE SCALE: 1" = 4,000'

FIGURE 1-2  
 ROCKY FLATS PLANT

OPERABLE UNIT NO. 13  
 PHASE I RFI/RI WORK PLAN  
 U.S. DEPARTMENT OF ENERGY  
 Rocky Flats Plant, Golden, Colorado

### 1.3.4.3 Meteorology and Climate

Atmospheric contaminant transport is controlled by the following parameters: climate; local meteorology; local topography; large structures or buildings onsite; and contaminant source, concentration, and physical/chemical characteristics (e.g., phase, volatility, solubility, and density).

#### Climate

The climate at the RFP is strongly influenced by the Front Range of the Rocky Mountains. Dry, cool winters with some snow cover and warm, moderately-moist summers characterize the Rocky Flats climate. The temperatures average a maximum of 24.4° C (76° F) and a minimum of -5.56° C (22° F), with an average annual mean temperature of 9.78° C (49.6° F). The temperature extremes recorded at the RFP range from 38.89° C (102° F) in July to -32.22° C (-26° F) in January (Schleicher, 1982). Infrequent cloud cover over the region allows intense solar heating of the ground surface during the day, and the low absolute humidity allows significant radiation cooling at night. The average relative humidity averaged 46 percent for the period between 1954-1976 (Rockwell, 1989b).

The regional topography and upper-level wind patterns over North America create a semi-arid climate along the foothills of the Front Range. Average annual precipitation is 15.16 inches. The maximum annual precipitation, recorded in 1969, was 24.87 inches. More than 80 percent of the precipitation occurs as rain between April and September, with the remainder of the precipitation occurring as snowfall in the winter months (Rockwell 1989). Snowfall at the RFP

occurs during the months of November through March, although occasional snowstorms occur in April, May, and October.

### Local Meteorology

Local meteorology is influenced by local topography, mountain ranges, and large scale weather systems. The orientation of the bordering mountain range, as well as the general orientation of the Front Range of the Rocky Mountains play an important role in determining the wind regime. The RFP is in the belt of prevailing northwesterly winds which are normally channeled across the geological bench called Rocky Flats.

Local mountain and valley features exert a strong influence on the wind flow under other meteorological conditions. When winds above the gradient level are strong and from a direction slightly north of west, channeling in the eastern Rocky Flats bench usually continues to produce northwesterly winds over most of the RFP.

Drainage winds also contribute to the overall area wind flow over the RFP. On clear or partly cloudy nights, the valley experiences rapid surface radiational cooling. This results in simultaneous cooling of the air near the surface which causes the air to become stable and less turbulent. However, air along the slopes of the Front Range cools at a faster rate than air at the same elevation located over the valleys. Consequently, it becomes more dense and flows or sinks toward the valley forming a down-slope wind. When this wind reaches the valley, it still flows toward lower elevations and becomes a down-valley wind.

Meteorology of the RFP is strongly influenced by the diurnal cycle of mountain and valley breezes. The Front Range, located west of the RFP, is broken by several canyons that run

generally east-west. These canyons also serve to channel airflow, especially when there is strong atmospheric stability. Two dominant flow patterns exist, one during daytime conditions and one at night. During daytime hours as the earth heats, the mountains receive more direct sunlight than the plains and valleys, causing air to heat and rise. The result is a general trend for the airflow to travel toward the higher elevations (upslope condition). The general airflow pattern during upslope conditions for the Denver area is typically north to south with the flow moving up the South Platte River Valley and entering the canyons into the Front Range. After sunset, air against mountainsides cools and begins to flow toward the lower elevations (downslope conditions). The airflow pattern for the Denver area during downslope conditions is down the canyons of the Front Range onto the plains. This flow converges with the South Platte River Valley flow moving toward the north-northeast.

Strong convective activity and thunderstorms are common in the area during summer. This activity can produce severe anomalies on the normal airflow patterns because of strong inflow regions or outflow microbursts caused by the accompanying rain shafts. During late winter and spring, the meteorology can be influenced by chinook windstorms. The chinook phenomenon is characterized by strong winds moving from the west to the east over the continental divide. These winds often reach 70-80 mph (31.2-35.7 m/s) and have been recorded in excess of 120 mph (53.65 m/s) at the RFP. (Rockwell, 1989).

The mean wind speed for 1990 was 4.0 m/s (9.0 mph) with the highest wind speed reported at 39.6 m/s (88.6 mph) (EG&G, 1991). Figure 1-3 gives the wind rose for the RFP, with compass point designations indicating the true bearing when facing against the wind (EG&G 1990). The predominance of northeasterly winds and low frequency of winds greater than 7 m/s (15.6 mph) with easterly components is typical at the RFP (EG&G 1990).



#### 1.3.4.4 Surface Water Hydrology

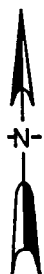
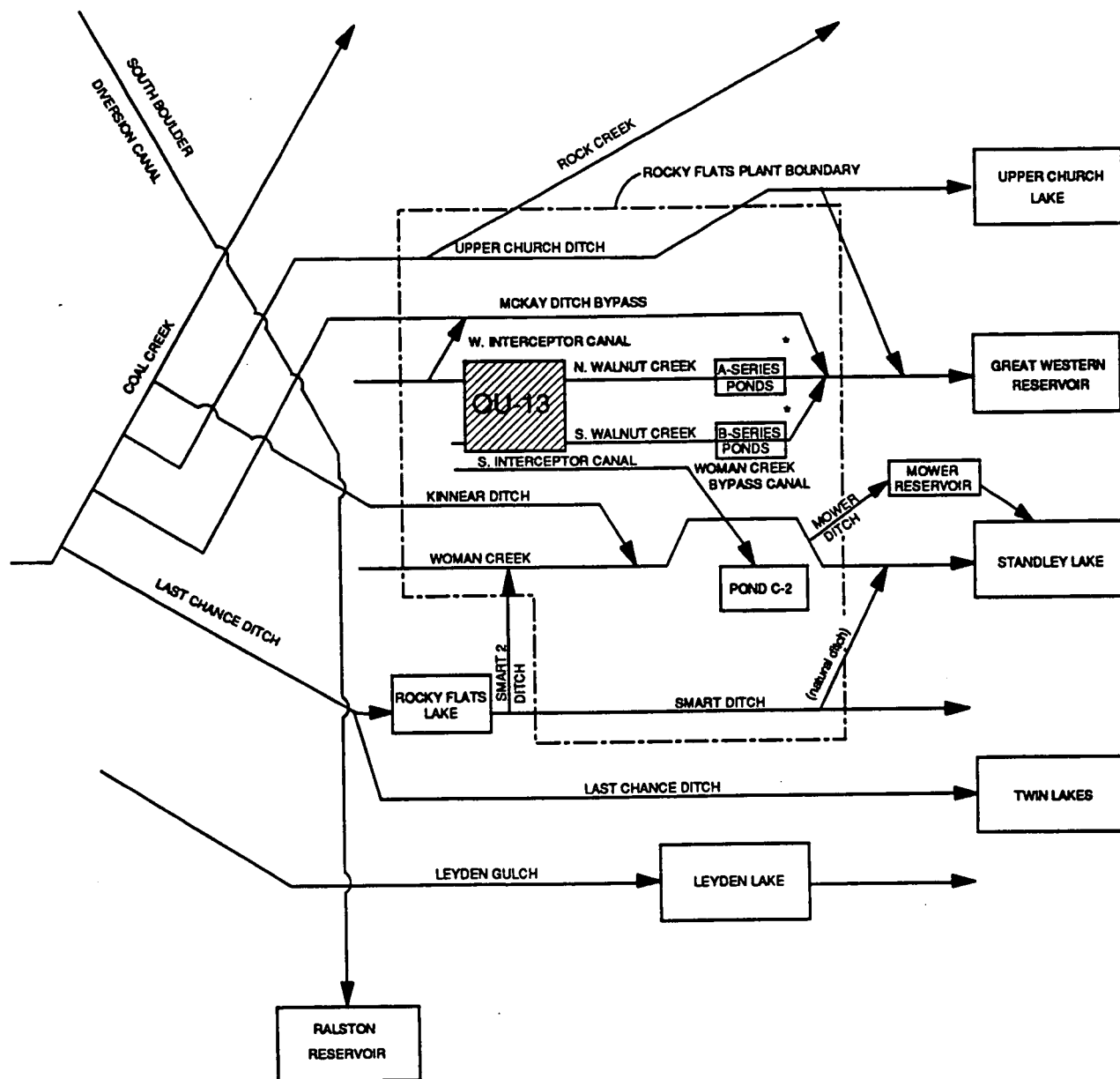
Three streams -- Rock Creek, Walnut Creek, and Woman Creek -- drain the RFP area and flow generally from west to east. Figure 1-4 provides an overview of the surface water features in the vicinity of the RFP. Rock Creek drains an area of the RFP buffer zone generally to the northwest of the RFP Controlled Area, flowing into Coal Creek offsite to the north. Walnut Creek is formed by the combined flows from North Walnut Creek and South Walnut Creek, which drain the central and northern areas of the RFP, respectively, along with an unnamed tributary draining a northern part of the RFP area. These three tributaries join in the buffer zone, and Walnut Creek flows towards the Great Western Reservoir to the east. However, Walnut Creek flows generally are diverted around Great Western Reservoir into Big Dry Creek through the Broomfield Diversion Ditch.

North Walnut Creek is a perennial stream, whereas Rock Creek, South Walnut Creek, and the unnamed tributary to North Walnut Creek are all intermittent streams. Flows occur in these streams primarily as a result of spring-season snowmelt and after precipitation events. Woman Creek flows throughout the year during some years. It originates to the west of the RFP, drains the southern buffer zone area, and flows eastward (Figure 1-4). The South Interceptor Ditch is located between the RFP Controlled Area and Woman Creek; it collects runoff from the southern part of the RFP and diverts this to Pond C-2. Waters from Pond C-2 are pumped, treated, and discharged into Walnut Creek downstream of the eastern RFP boundary. Most of the remaining surface water runoff in the Woman Creek drainage outside of the South Interceptor Ditch drainage flows offsite to the east. Part flows into Mower Reservoir, but most goes into Standley Lake.

The Rock Creek drainage is located in the north part of the RFP. Coal Creek flows west and north of the RFP and is joined by Rock Creek northeast of the RFP. Coal Creek flows into Boulder Creek, then St. Vrain Creek, and eventually the South Platte River.

Eight ditches convey water throughout the general RFP area: South Boulder Diversion Canal, Last Chance Ditch, Upper Church Ditch, McKay Ditch Bypass, Smart Ditch, Smart 2 Ditch, Mower Ditch, and Kinnear Ditch. Figure 1-5 provides a schematic diagram of the surface water drainage system in the vicinity of the Rocky Flats Plant. The Upper Church Ditch, McKay Ditch Bypass, Kinnear Ditch, and Last Chance Ditch all divert water from Coal Creek to the east; the Smart Ditch diverts water from Rocky Flats Lake to the east; and the Smart 2 Ditch diverts water from the Smart Ditch to a Woman Creek tributary (Figure 1-5). The Mower Ditch diverts water from Woman Creek into Mower Reservoir. The South Boulder Diversion Canal is located west of the RFP and is unlined in the vicinity of the RFP, except for a cement-lined 100-meter aqueduct that crosses the Woman Creek drainage. All other irrigation ditches within the RFP referenced above are unlined and tend to lose water through seepage into the underlying subsurface materials.

In addition to the ditches described above, other surface water management controls also are in operation at the RFP. The West Interceptor Canal (Figure 1-5) diverts runoff from the headwaters of North Walnut Creek via the McKay Ditch Bypass to Walnut Creek west of Indiana Street. The South Interceptor Canal collects runoff from the southern parts of the RFP before it reaches Woman Creek and diverts the collected water into Pond C-2. In addition to ditches and canals, a series of detention ponds have been constructed to control the release of the RFP discharges and to collect surface runoff. See Section 2.1.5, Surface Water Hydrology for more details regarding the detention ponds on the east side of the plant.



• See Figure 2-15 for details.

Adapted from HURR (1976)

## SCHEMATIC DIAGRAM OF SURFACE-WATER SYSTEM

### OU-13 WORK PLAN



PROJECT 208.13

FIGURE 1-5



#### 1.3.4.5 Precipitation

Precipitation in the RFP area primarily occurs as snowfall or short-duration thunderstorms. These localized thunderstorms are generally one hour or less in duration, and their areal extent is usually limited to approximately one square mile (ASI, 1991a). The precipitation data are collected and recorded in the West Buffer Zone Meteorological Station (MetSta). Over the long term, the annual precipitation at the RFP has averaged nearly 15.2 inches (ASI, 1991c). Annual evaporation at the RFP site is estimated to be between 31 and 38 inches. This is based upon long-term records at Cherry Creek Dam and the City of Fort Collins, respectively (ASI, 1991c). The Cherry Creek Dam is located in the Denver metropolitan area approximately 25 miles southeast of the RFP. Fort Collins is located approximately 45 miles north of the RFP. These two sites are meteorologically similar and, therefore, the evaporation rates are considered representative of the RFP evaporation rates.

#### 1.3.4.6 Ecology

A variety of plant life is found within the RFP. The dominant vegetation found on the western portion of the site is disturbed mixed prairie, a mixture of both short and mid grasses. The eastern portion of the RFP is generally highly disturbed through overgrazing, with short grasses being dominant. Sedges (*Carex nebraskensis*) and rushes (*Juncus arcticus*) are found in stream flood-plains and wet valley-bottoms. Cottonwoods (*Populus sargentii*) and cattails (*Typha latifolia*) line many riparian areas (Clark, 1977).

Vegetative recovery has occurred in the buffer zone area, as evidenced by the presence of disturbance-sensitive species such as big bluestem (*Andropogon gerardii*) and side oats grama (*Bouteloua curtipendula*). None of the vegetative species at the RFP are reported to be on the

endangered species list (EG&G, 1991b). No vegetative stresses attributable to hazardous waste contamination have been identified (DOE, 1980).

Animal populations within the RFP are representative of western prairie regions. The presence of a chain-link fence surrounding the controlled area effectively limits the occurrence of the most common large mammal, the mule deer (*Odocoileus hemionus*), to the buffer zone. The permanent population of mule deer is estimated to be 100 to 125. There are a number of small carnivores, such as the coyote (*Canis latrans*), red fox (*Vulpes fulva*), striped skunk (*Mephitis mephitis*), and the long-tailed weasel (*Mustela frenata*). Small herbivores are common throughout the plant complex and buffer zone, including the pocket gopher (*Thomomys sp.*), white-tailed jackrabbit (*Lepus townsendii*), and the meadow vole (*Microtus pennsylvanicus*) (DOE, 1980).

Commonly observed birds include horned larks (*Eremophila alpestris*), western meadowlarks (*Sturnella neglecta*), mourning doves (*Zenaidura macroura*), vesper sparrows (*Pooectes gramineus*), western kingbirds (*Tyrannus vociferans*), black-billed magpies (*Pica pica*), American robins (*Turdus migratorius*), and yellow warblers (*Dendroica magnolia*). Mallards (*Anas platyrhynchos*) and other ducks (*Anas sp.*) often nest and rear young on several of the ponds. Killdeer (*Chradrius vociferus*) and red-winged black birds (*Agelaius phoeniceus*) are found in areas adjacent to the ponds. Birds of prey commonly seen in the area include marsh hawks (*Circus cyaneus*), red-tailed hawks (*Buteo jamaicensis*), ferruginous hawks (*Buteo regalis*), rough-legged hawks (*Buteo lagopus*), and great horned owls (*Bubo virginianus*) (DOE, 1980).

Rattlesnakes (*Crotalus sp.*) and bull snakes (*Pituophis melanoleucus*) are the most frequently appearing reptiles. Eastern yellow-bellied racers (*Coluber constrictor flaviventris*) have also been seen. The eastern short-horned lizard (*Phrynosoma douglassi brevirostre*) has been reported on the site, but these and other lizards are not commonly seen. The western painted turtle

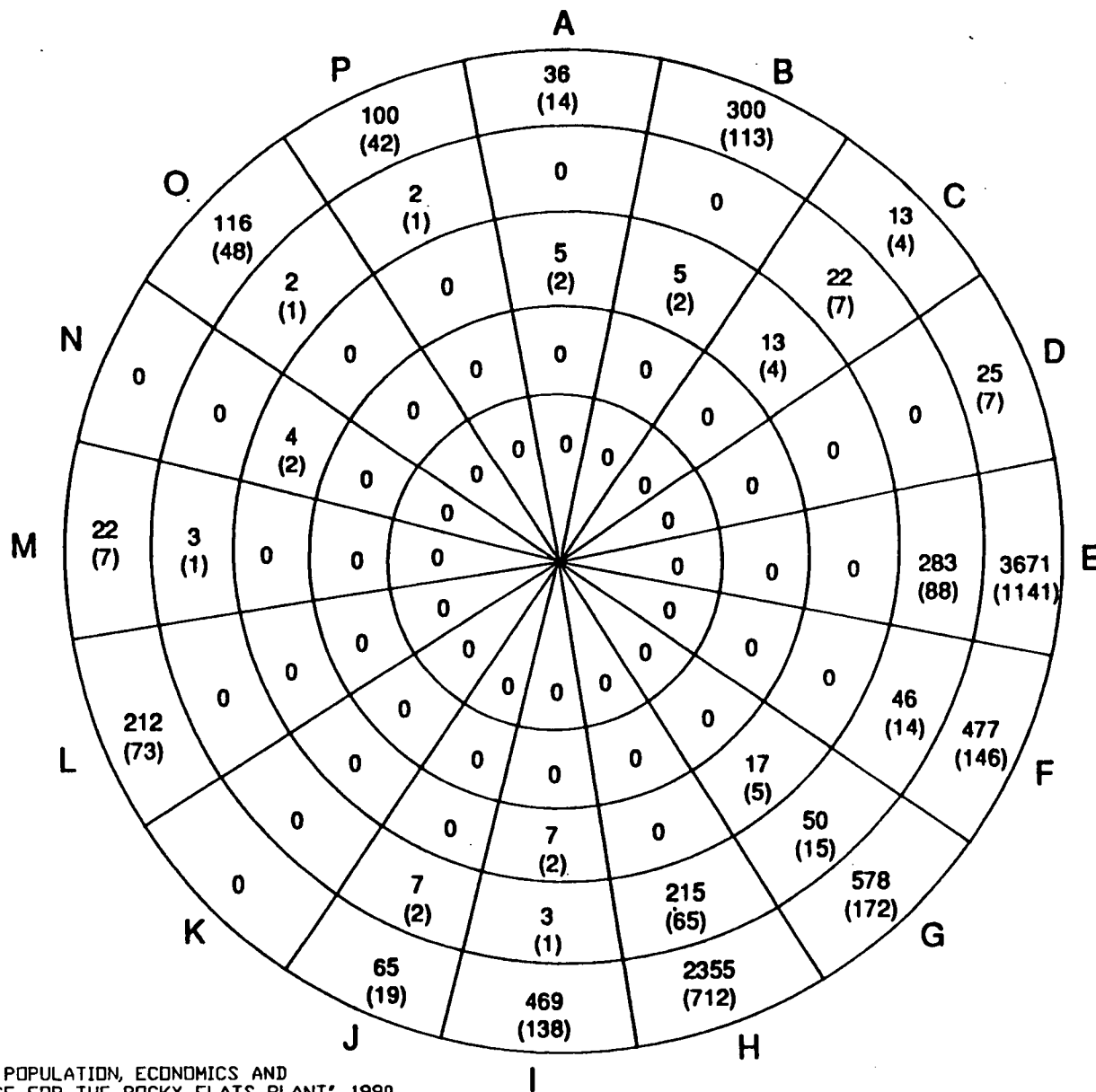
(*Chrysemys picta*) and the western plains garter snake (*Thamnophis radix*) are found in and around many of the ponds (DOE, 1980).

Two procedures which concern the identification and management of threatened and endangered species at the RFP are currently under preparation by the EG&G National Environmental Policy Act (NEPA) Group. These are the draft Identification and Reporting of Threatened and Endangered and Special Concern Species, administrative procedure NEPA.12, Rev. 0, and the draft Protection of Threatened and Endangered and Special Concern Species, OP FO.21, Rev.0.

#### 1.3.4.7 Surrounding Land Use and Population Density

The population, economics, and land use of areas surrounding the RFP are described in a 1989 Rocky Flats vicinity demographics report prepared by DOE (DOE, 1991b). This report divides general use of areas within 0 to 10 miles of the RFP into residential, commercial, industrial, parks and open spaces, agricultural and vacant, and institutional classifications. It also considers current and future land use near the RFP.

The majority of residential use within 5 miles (8 km) of the RFP is located northwest, west, southwest, and south of the RFP. Figure 1-6 shows the 1989 population distribution within a 5-mile radius from the center of the RFP. Commercial development is concentrated near the residential developments around Standley Lake, primarily north and southwest, and around the Jefferson County Airport (Jeffco) which is located approximately 3 miles (4.8 km) northeast of the RFP. Active industrial land use within 5 miles (8 km) of the plant is limited to quarrying and mining operations located on lands directly west and southwest of the RFP. There are several pockets of industrially-zoned property located all around the RFP, both directly adjacent and nearby. This property is not likely to be developed in the near future due to a lack of water



Miles	Sector Name
0-1	Sector 1
1-2	Sector 2
2-3	Sector 3
3-4	Sector 4
4-5	Sector 5



NOT TO SCALE

SOURCE: DOE, '1989 POPULATION, ECONOMICS AND LAND USE DATA BASE FOR THE ROCKY FLATS PLANT', 1990

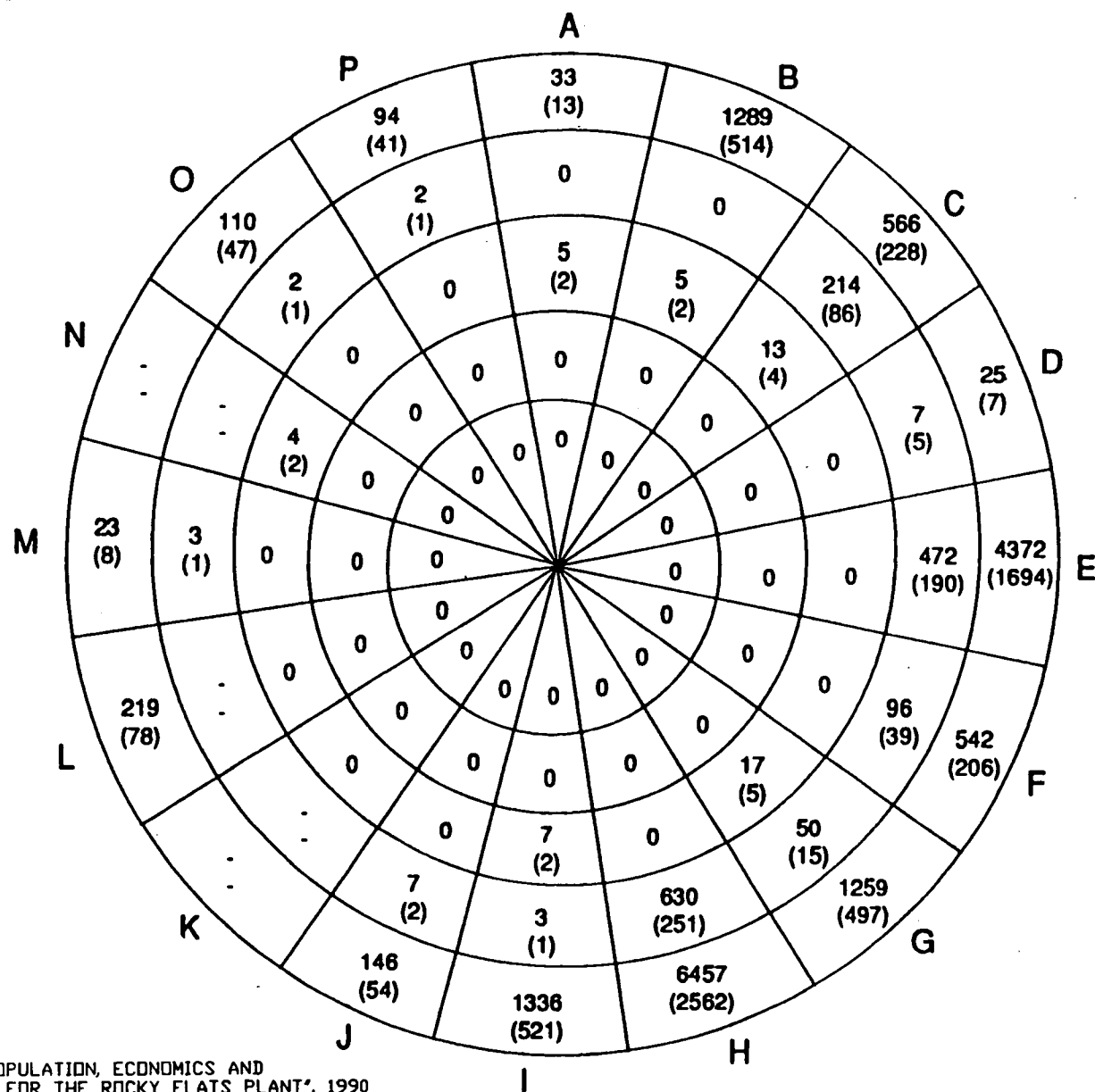
**FIGURE 1-6**  
**1989 POPULATION DISTRIBUTION, WITHIN 5 MILES**  
**OF THE ROCKY FLATS PLANT SITE**

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for fire protection. These properties must be accepted into a fire protection district in order to be developed for commercial or industrial use and no fire protection district is willing to accept the properties at this time. Open space lands are located northeast of the RFP, near the City of Broomfield, and in small parcels adjoining major drainages and small neighborhood parks in the cities of Westminster and Arvada. Standley Lake is surrounded by Standley Lake Park. Irrigated and nonirrigated croplands, producing primarily wheat and barley, are located northeast of the RFP near the cities of Broomfield, Lafayette, and Louisville; north of the RFP near Louisville and Boulder; and in scattered parcels adjacent to the eastern boundary of the RFP. Several horse operations and small hay fields are located south of the RFP.

#### 1.3.4.8 Future Population and Land Use Projections

Future land use in the vicinity of the RFP will most likely involve continued suburban expansion, increasing the density of residential, commercial, and industrial land use in the surrounding areas. The expected trend in population growth in the vicinity of the RFP is addressed in the DOE demographics study (DOE, 1991b). This report considers expected variations in population density by comparing the current (1989) setting to population projections for the years 2000 and 2010. A 21-year profile of projected population growth in the vicinity of the RFP can thus be examined. The DOE projections are based primarily upon long-term population projections developed by the Denver Regional Council of Governments (DRCOG). Expected population density and distribution around the RFP for the years 2000 and 2010 are shown in Figures 1-7 and 1-8, respectively.



Miles	Sector Name
0-1	Sector 1
1-2	Sector 2
2-3	Sector 3
3-4	Sector 4
4-5	Sector 5

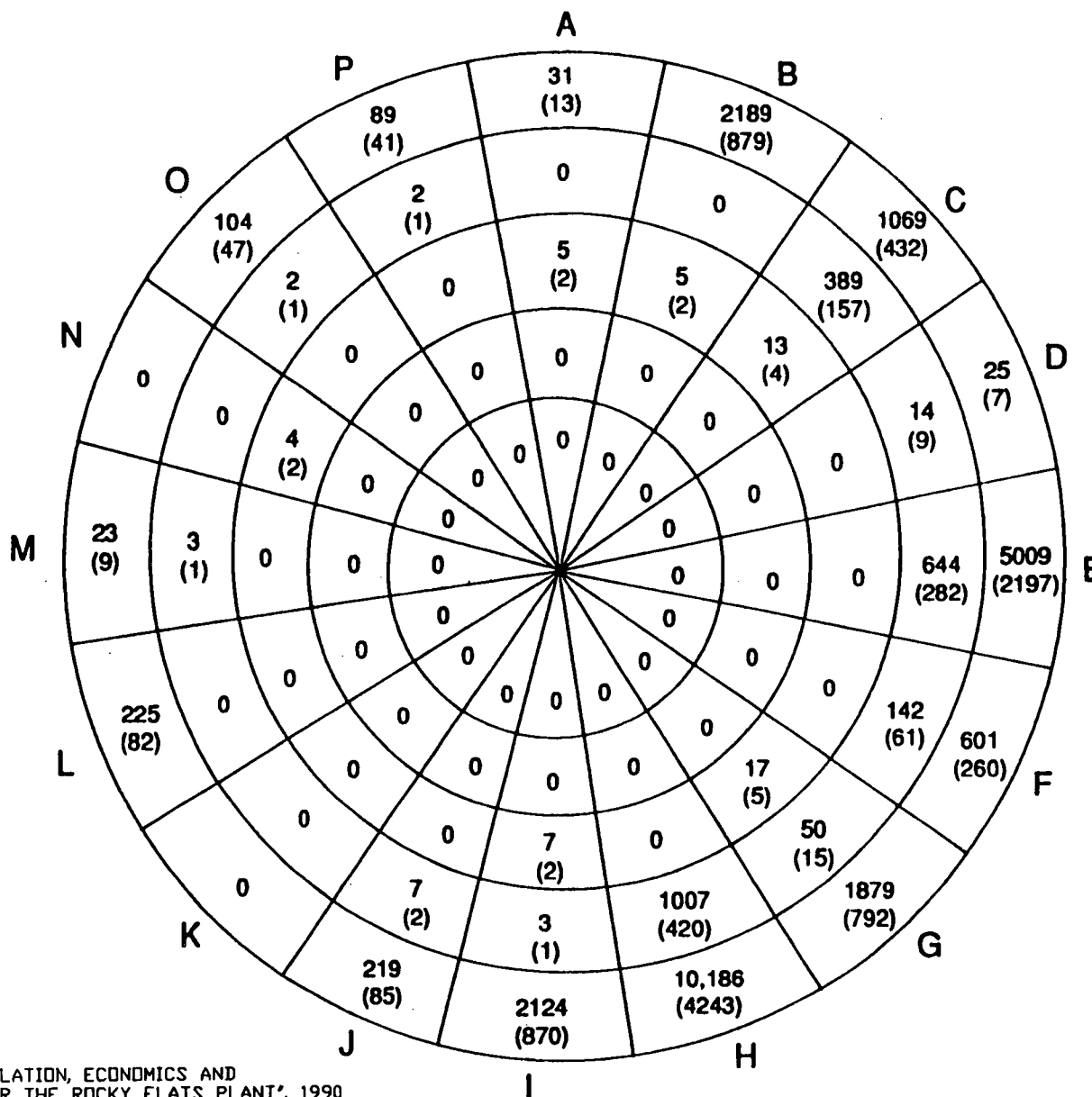


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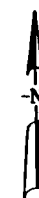
SOURCE: DOE, '1989 POPULATION, ECONOMICS AND LAND USE DATA BASE FOR THE ROCKY FLATS PLANT', 1990

FIGURE 1-7  
EXPECTED POPULATION AND DENSITY DISTRIBUTION AROUND  
THE ROCKY FLATS PLANT IN THE YEAR 2000

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Miles	Sector Name
0-1	Sector 1
1-2	Sector 2
2-3	Sector 3
3-4	Sector 4
4-5	Sector 5



NOT TO SCALE

SOURCE: DOE, '1989 POPULATION, ECONOMICS AND LAND USE DATA BASE FOR THE ROCKY FLATS PLANT', 1990

FIGURE 1-8  
EXPECTED POPULATION AND DENSITY DISTRIBUTION AROUND  
THE ROCKY FLATS PLANT IN THE YEAR 2010

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Rocky Flats Plant, Golden, Colorado

#### 1.3.4.9 Regional Geology and Hydrogeology

The RFP is located on gravelly alluvium that covers an eastward-sloping pediment surface. Bedrock is exposed locally along streams that have dissected the pediment. The surficial geology and general geologic setting for the RFP and vicinity are shown in Figure 1-9.

The groundwater is recharged by infiltration of rainfall, snowmelt, stream seepage, and irrigation water into the surficial materials and bedrock. Flow of groundwater is in the general direction of the slope of the ground surface, primarily eastward. Discharge from the surficial materials is via springs and seeps along valley walls near the bedrock contact. Discharge from shallow bedrock is to the eastward flowing streams that dissect the alluvium covered pediment.

#### Surficial Deposits

The surficial deposits covering the pediment surface in the immediate vicinity of the RFP comprise the Rocky Flats Alluvium. This alluvium is Quaternary in age and was deposited as an alluvial fan with its apex at the mouth of Coal Creek Canyon. The alluvial fan material was transported as outwash from glaciers that were located five miles to the west at higher elevations in the Front Range (Baker, 1973). It is composed of poorly- to moderately-sorted, poorly-stratified clay, silt, sand, gravel, and cobbles. The coarse clastic materials were derived primarily from Front Range provenance areas which are composed of Precambrian crystalline metaquartzites, metabasalts, pelitic schists, and younger granitoids of the Boulder Creek and Silver Plume Granites.

The Rocky Flats Alluvium is the surficial material beneath nearly all structures at the RFP, where the alluvium thickness ranges up to 100 feet. The alluvium is absent where it has been removed



by downcutting of the streams (Walnut Creek and Woman Creek) in the vicinity. The depositional surface declines approximately 300 feet from the western edge of the RFP peripheral buffer zone to the eastern edge of the buffer zone. This distance is 3.4 miles, and the slope is 88 feet per mile.

Local colluvial deposits are present on steeper slopes flanking drainages at the RFP. These deposits are derived from Rocky Flats Alluvium located upslope. Most bedrock is concealed beneath the colluvial material.

The bottoms of the stream valleys contain Quaternary alluvium deposited by the streams. Minor linear wetlands are present on these alluvial materials (EG&G, 1990).

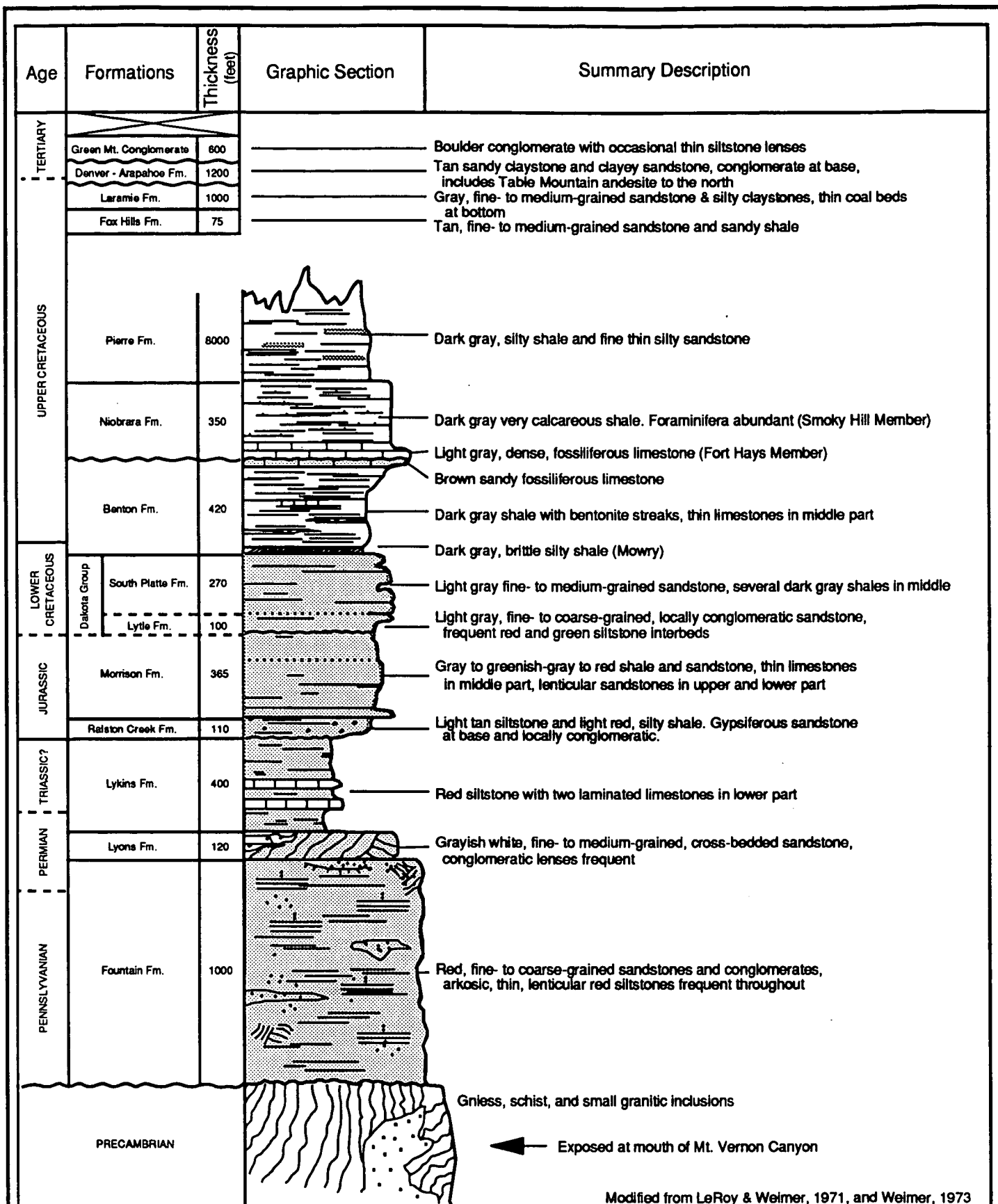
The dominant soil developed on the Rocky Flats Alluvium is the Flatiron Series. These soils are very cobbly sandy loams with a slow infiltration rate where slopes are 0 to 3 percent. Nederland Series soils are also present and consist of very cobbly sandy loams with a moderate infiltration rate. They are preferentially developed adjacent to the Flatiron Series along the periphery of the Rocky Flats Alluvium where slopes are 15 to 50 percent. A third soil is the Denver-Kutch-Midway Series. These soils are clay loams developed on Arapahoe Formation claystones with slopes of 9 to 25 percent. Soils in the vicinity of the RFP are shown in Figure 1-10. The preceding information regarding soils at and adjacent to the RFP is derived from the Soil Conservation Service, 1980. Presently these natural soils are partly obscured by fill, gravel, and buildings at the RFP.

## Bedrock Geology

Figure 1-11 is a generalized stratigraphic section showing bedrock units exposed near the east edge of the Front Range in the Golden-Morrison area, a few miles south of the RFP. Figure 1-12 is a detailed stratigraphic section of the youngest units at the RFP. These units dip generally eastward, as shown in Figure 1-13 and are present in the subsurface beneath the RFP.

The upper Cretaceous Arapahoe Formation is the uppermost bedrock unit at Rocky Flats. Surficial deposits unconformably overlie this formation. The Arapahoe Formation was weathered and eroded during pedimentation and was eventually covered by the Rocky Flats Alluvium. According to the Geologic Characterization Report for the RFP (EG&G, 1991), the Arapahoe Formation is 150 feet thick beneath the central portion of the RFP. However, it rests conformably on the Laramie Formation (Weimer, 1973), and the position of the Arapahoe/Laramie contact is being evaluated. Results from a recent surface mapping project (EG&G, 1992) suggest that the Arapahoe Formation is generally less than 50 feet thick. The lithologic composition is mainly claystone and silty claystone with sandstone bodies present. Most of the sandstone is very fine to medium fine grained, poorly to moderately but occasionally well-sorted, subangular to subrounded, silty and clayey. Some coarse-grained to conglomeratic sandstone is present. The sandstone bodies are thought to be lenticular and laterally discontinuous. The Arapahoe Formation at the RFP has been interpreted as channel, point bar, and overbank deposits of a fluvial system (EG&G, 1991).



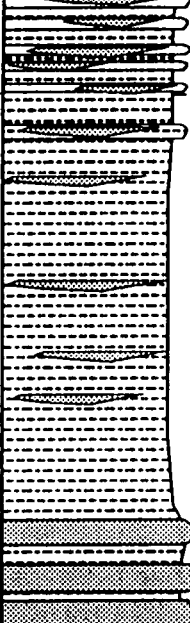
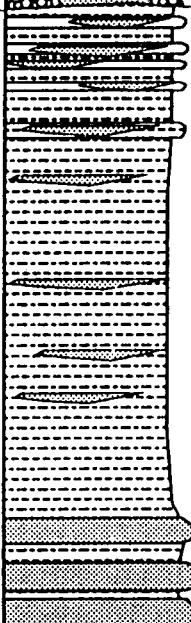
The Laramie Formation is approximately 800 feet thick at the RFP. The formation is divided into two intervals: a lower unit of sandstone, siltstone, and claystone with coal layers; and an upper claystone unit (EG&G, 1991a). The sandstones are fine to coarse grained, poorly sorted,



# GENERALIZED STRATIGRAPHIC SECTION, GOLDEN-MORRISON AREA

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U.S. DEPARTMENT OF ENERGY **FIGURE 1-11**  
Rocky Flats Plant, Golden, Colorado

Age	Formation	Thickness (feet)	Rocky Flats Graphic Section	Rocky Flats Graphic Section	Thickness (feet)	Formation	Summary Description
Quaternary	Rocky Flats Alluvium	0-100	EG&G (1991e) (central portion RFP) 	This Study (central portion RFP) 	10-20	Rocky Flats Alluvium	Clayey Sandy Gravels - reddish brown to yellowish brown matrix, grayish-orange to dark gray, poorly sorted, angular to subrounded, cobbles, coarse gravels, coarse sands and gravelly clays; varying amounts of caliche
	Arapahoe Formation	150			15-25	Arapahoe Fm.	Claystones, Silty Claystones, and Sandstone - light to medium olive-gray with some dark olive-black claystone and silty claystone weathers yellowish orange to yellowish brown; a mappable, light to olive gray, medium- to coarse-grained, frosted sandstone to conglomeratic sandstone occurs locally at the base (Arapahoe marker bed)
Cretaceous	Laramie Formation	800			600-800	Laramie Formation	Claystones, Silty Claystones, Clayey Sandstones, and Sandstones - kaolinitic, light to medium gray claystone and silty claystone and some dark gray to black carbonaceous claystone, thin (2') coal beds and thin discontinuous, very fine to medium-grained, moderately sorted sandstone intervals
		upper interval: 500 lower interval: 300			upper interval: 300-500 lower interval: 300		Claystones, Sandstones, and Coals - light to medium gray, fine- to coarse-grained, poorly to moderately sorted, silty, immature quartzitic sandstone with numerous lenticular, sub-bituminous coal beds and seams that range from 2' to 8' thick
	Fox Hills Sandstone	75-125			90-140	Fox Hills Sandstone	Sandstones - grayish orange to light gray, calcareous, fine-grained, subrounded, glauconitic, friable sandstone
	Pierre Shale and older units					Pierre Shale and older units	

#### LEGEND

					
Alluvium-Sandy Gravel	Conglomeratic Sandstone	Fine to Medium Sandstone	Very Fine to Fine Sandstone	Claystones and Siltstones	Claystones and Silty Claystones (Shale)

Source: Phase II Geologic Characterization Data Acquisition, Surface Geologic Mapping of the Rocky Flats Plant and Vicinity, Jefferson and Boulder Counties, Colorado, Final Report, EG&G Rocky Flats, Inc., March, 1992

## REVISED STRATIGRAPHIC SECTION CENTRAL PORTION, ROCKY FLATS PLANT

## OPERABLE UNIT 13 PHASE I RFI/RI WORK PLAN

U.S. DEPARTMENT OF ENERGY  
Rocky Flats Plant, Golden, Colorado

FIGURE 1-12

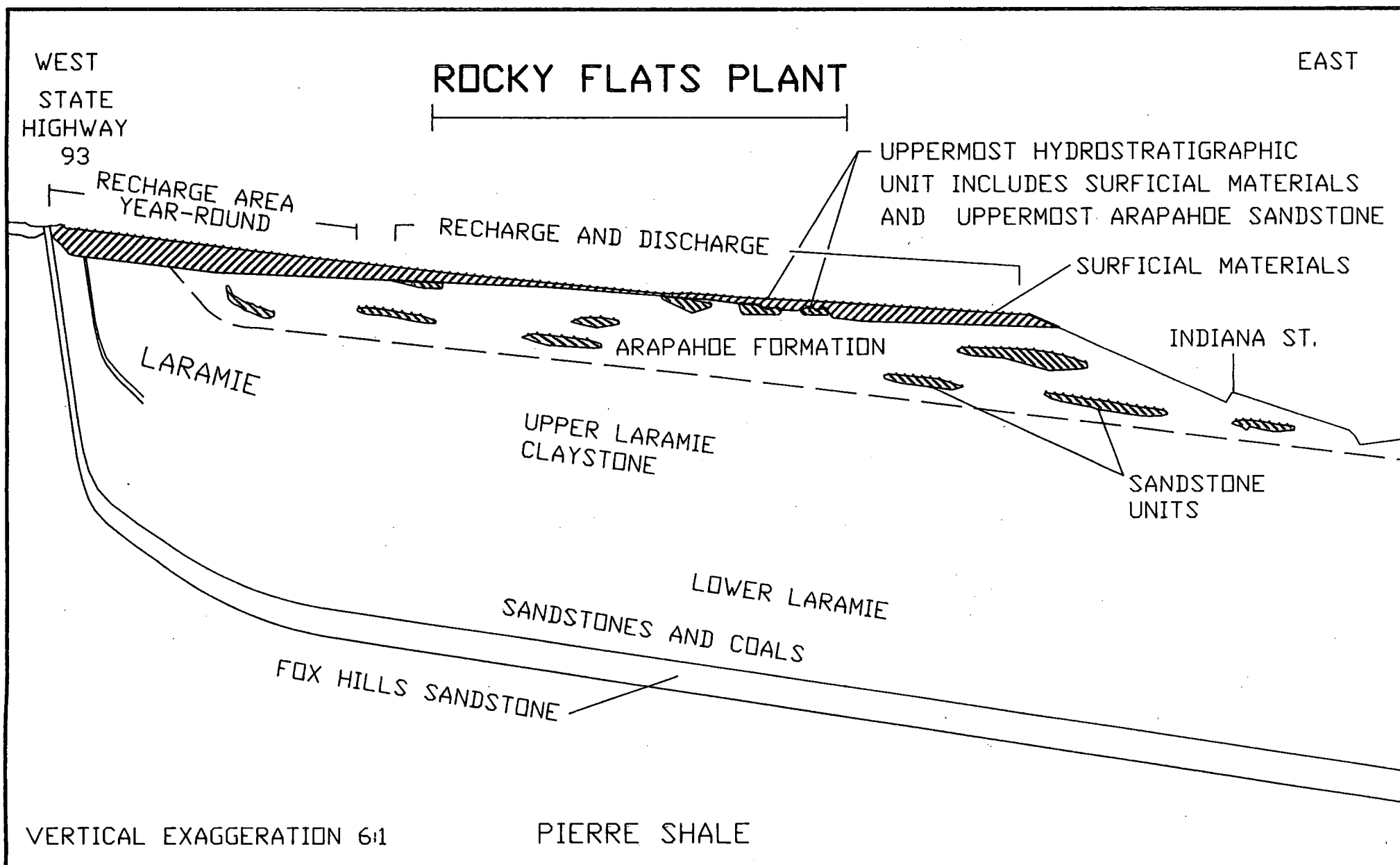


FIGURE 1-13  
SCHEMATIC WEST TO EAST STRUCTURAL CROSS SECTION

OPERABLE UNIT NO. 13  
PHASE I RFI/RI WORK PLAN

U.S. DEPARTMENT OF ENERGY

OU131-13.DWG

Rocky Flats Plant, Golden, Colorado

subangular and silty. The upper interval is about 500 feet thick at the RFP (Figure 1-12), consisting of light to medium gray kaolinitic claystones with some dark grey to black carbonaceous claystones (EG&G, 1991). The Laramie Formation originated in a delta plain depositional environment.

The regional structural setting of the RFP is on the western flank of the Denver Basin, approximately four miles east of the steeply dipping strata on the eastern flank of the Front Range uplift. The generalized west to east structure beneath the RFP is shown in Figure 1-13. The most prominent feature is a monoclinial fold which strikes roughly north-south. The bedrock dips steeply eastward in the west portion of the RFP, as shown by the 50 degree dip of the Fox Hills and Laramie Formations. These then flatten to a dip of no more than 1 to 2 degrees.

### Hydrogeology

The RFP is situated in a regional groundwater recharge area. The groundwater system is dynamic with rapid changes in the level of the water table in response to precipitation and other short-term stresses to the groundwater system. Generally, water levels are highest in early summer (June) and lowest during the winter months. Hydrostratigraphic units that exist in the strata beneath the RFP in the surficial materials and the underlying Cretaceous bedrock are shown in Figure 1-13.

## Hydrostratigraphic Units

### Water Table (Unconfined) Aquifer

The water table (unconfined) aquifer at the RFP is primarily the unconsolidated alluvial material. It includes the Rocky Flats Alluvium, which is present on broad topographic highs, colluvium along valley slopes, and the Valley Fill Alluvium present in modern stream drainages (Figure 1-9). In the western part of the RFP, where the alluvial material is thickest, the depth to the water table is 50 to 70 feet below the surface. Although the water table depth is variable, it becomes shallower from west to east as the alluvial material thins. In the stream drainages, seeps are common at the base of the Rocky Flats Alluvium (EG&G, 1991a) and where individual Arapahoe Formation sandstones crop out.

Generally, the groundwater flows along the contact of the unconsolidated material and the Arapahoe Formation claystones in a downgradient direction to the east. The claystones have a low hydraulic conductivity, on the order of  $1 \times 10^{-7}$  cm/s (EG&G, 1991a), effectively constraining much of the flow within the water table aquifer to the alluvial material above the alluvium/bedrock unconformity. Locally, however, a potential hydraulic connection exists between the uppermost Arapahoe Formation sandstone unit and the surficial materials (EG&G, 1991d), allowing them to function as a single water table aquifer in a limited area. The lower sandstones of the Arapahoe Formation also subcrop beneath alluvium and colluvium along valley slopes, therefore also existing as part of the water table aquifer in limited areas.

### Confined Aquifers

Groundwater in the sandstone units of the Arapahoe Formation occurs under confined conditions over most of the RFP. The confining layers for the sandstones are claystones and silty claystones.

The Laramie/Fox Hills aquifer crops out at the west end of the RFP and dips at 45 to 50 degrees to the east. Gradually the dip decreases to less than two degrees beneath the central part of the RFP where the Laramie/Fox Hills is separated from the RFP activities by several hundred feet of claystone (Hurr, 1976; EG&G, 1991a). The claystone is an aquitard which separates the RFP activities from the Laramie/Fox Hills aquifer (Figure 1-13).

### Recharge and Discharge

Groundwater recharge occurs as infiltration of precipitation to confined aquifers where bedrock crops out in the western portion of the RFP along the west limb of the monoclinal fold and to the unconfined aquifer through unconsolidated material and subcropping permeable bedrock throughout the area. Recharge also occurs as a result of infiltration of surface water from streams, ditches, and ponds. At the local level, there are areas of discharge as well as recharge. Baseflow of some of the perennial streams is sustained by groundwater discharge. Additionally, groundwater within the surficial materials and underlying permeable bedrock (Arapahoe sandstones) discharges at seeps along slopes in the valleys and becomes surface water or evaporates.



### Hydraulic Conductivities

No conclusive data are available for the recent alluvial and colluvial deposits. An aquifer test conducted near Woman Creek in OU1 indicates a relatively high hydraulic conductivity of  $1.8 \times 10^{-2}$  cm/s for the Valley Fill Alluvium (Doty & Associates, 1992). Packer tests performed in 1986 and 1989 provide estimates of hydraulic conductivity for the Rocky Flats Alluvium and the uppermost Arapahoe Formation sandstone (EG&G, 1991d). The Rocky Flats Alluvium of the uppermost hydrostratigraphic unit has a hydraulic conductivity of roughly  $6 \times 10^{-5}$  cm/sec in Well 1-89. This value is comparable to the hydraulic conductivity of  $8 \times 10^{-5}$  cm/sec for the highly-weathered and unconsolidated subcropping Arapahoe sandstone which also forms a part of the uppermost hydrostratigraphic unit in Well 3-86. Both of these values are much greater than the hydraulic conductivities of the Arapahoe claystones which are approximately  $1 \times 10^{-7}$  to  $1 \times 10^{-8}$  cm/sec for both weathered and unweathered claystone (EG&G, 1991d). The results of aquifer tests conducted in 1992 in the alluvium and the bedrock of the OU2 area are not yet available but are expected to provide additional and more reliable estimates of hydraulic conductivity.

In the subsurface, confined hydrostratigraphic units in the lower Arapahoe Formation have hydraulic conductivities of approximately  $1 \times 10^{-6}$  cm/sec. This value is intermediate to that of the hydrostratigraphic units in the Rocky Flats Alluvium and weathered subcropping Arapahoe sandstones ( $1 \times 10^{-5}$  cm/sec) and the Arapahoe claystones ( $1 \times 10^{-7}$  to  $1 \times 10^{-8}$  cm/sec) (EG&G, 1991c).

ROCKY FLATS PLANT  
Phase I RFI/RI Work Plan  
Operable Unit 13  
100 Area

Manual  
Section No.:  
Page:  
Organization:

21100-WP-OU13.01  
2.0, REV. 0  
1 of 179  
Environmental Management

TITLE: Site Characterization

Approved By:

02/01/93  
Effective Date

Michael J. McHugh  
Manager

10 / 9 / 92  
Date

## 2.0 SITE CHARACTERIZATION

### 2.1 BACKGROUND AND PHYSICAL SETTING OF OU13

OU13 is defined as IHSS 117.1, the North Chemical Storage Site; IHSS 117.2, the Middle Chemical Storage Site; IHSS 117.3, the South Chemical Storage Site; IHSS 128, the Oil Burn Pit No. 1 Waste Leak; IHSS 134, the Lithium Metal Destruction Site; IHSS 148, the Waste Spills; IHSS 152, the Fuel Oil Tank; IHSS 157.1, the North Area Radioactive Site; IHSS 158, the Building 551 Radioactive Site; IHSS 169, the Waste Peroxide Drum Burial; IHSS 171, the Solvent Burning Ground; IHSS 186, the Valve Vault 12; IHSS 190, the Caustic Leak; and IHSS 191, the Hydrogen Peroxide Spill. Although a boundary enclosing an area that contains the OU13 IHSSs is shown on many figures in this report to help orient the reader, IHSSs that are not included in OU13 are also located within this boundary. The boundary does not define the operable unit. It only shows the general location of the IHSSs of the operable unit.

IHSS 122, Underground Concrete Tanks, was included in the IAG definition of OU13 but has been transferred to OU9, the Original Process Waste Lines (OPWLs). Consequently, IHSS 122 is not listed above in the definition of OU13. The tanks are part of the OPWL system.

This section of the report describes the IHSSs in the operable unit first to show the location and nature of the sites. Then the natural physical features of the area containing the IHSSs are described to show the nature of the media involved in potential contamination. Then the contamination is described to the extent possible with existing information and data gaps are

identified. Finally, conceptual models indicating pathways from the IHSSs to potential receptors are presented.

### 2.1.1 Locations and Operational Histories of IHSSs





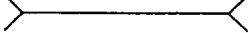


Information in the following discussion of IHSSs is taken from the Historical Release Report for the RFP (DOE, 1992a), engineering design drawings, and facilities drawings. Additional information on each IHSS is presented in Appendix A, which contains complete information gathered during development of this Work Plan. Locations of IHSSs with respect to plant buildings are shown on Figure 2-1.

#### 2.1.1.1 North Chemical Storage Site (IHSS 117.1)

IHSS 117.1 is located northeast of Building 552, west of Building 559, and northeast of the intersection of Sage and 7th Streets (Figures 2-3 and 2-4). Presently, the area includes a portion of the Protected Area, a storage area that contains a small amount of scrap metal, a contractor trailer parking area, a transformer, a valve vault, and two small buildings (223 and 549). Most of the area outside of the Protected Area is paved.

No documentation was found indicating when the area was first used for storage. However, an RFP photo from the 1950s shows indications of property use at this location. Past use of the site is reported to include non-radioactive waste and scrap metal disposal, as well as storage for building construction debris. Scrap metal was collected in the area until it was sold. Materials stored in the area were moved to the current PU&D Storage Yard in 1974. Reports indicate no chemical storage at this site, although automotive batteries may have been stored there.

ABDN	ABANDONED
A&M	ALARM & METERING
AS	ALARM SYSTEM-----2'-6' TO 3'-0' DEEP
CD	CONDUIT
CI	CAST IRON PIPE
CMP	CORRUGATED METAL PIPE
CN	CONDENSATION, STEAM
DCW	DOMESTIC COLD WATER
DCWF	DOMESTIC COLD WATER-FIRE
DISC	DISCONTINUED
E	ELECTRICAL-----1'-6' TO 3'-0' DEEP
GN	GAS, NATURAL
HW	HONEYWELL ALARM SYSTEM
KV	KILOVOLT
N2	NITROGEN
PE	POLYETHYLENE PIPE
PVC	POLYVINYL CHLORIDE PIPE
PW	PROCESS WASTE
RCP	REINFORCED CONCRETE PIPE
RW	RAW WATER
SD	STORM DRAIN
SS	SANITARY SEWER
STL	STEEL PIPE
STM	STEAM (5 P.S.I. & ABOVE)
T/TEL	TELEPHONE-----1'-0' TO 8'-0' DEEP
UC-1	UNDERGROUND CABLE-CLASS 1
UC-2	UNDERGROUND CABLE-CLASS 2
VCP	VITRIFIED CLAY PIPE
V	VOLT

	INDIVIDUAL HAZARDOUS SUBSTANCE SITE
	BUILDINGS
	FENCE
	UTILITY LINE ABANDONED
	CULVERT
	ASPHALT
	DIRT ROAD

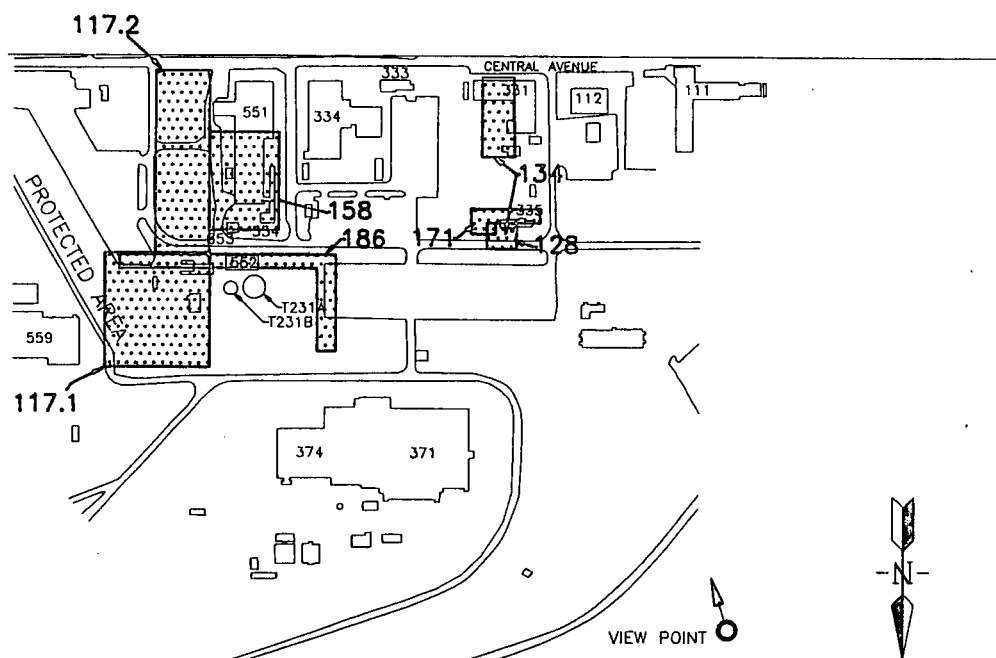
U.S. DEPARTMENT OF ENERGY  
Rocky Flats Plant  
Golden Colorado

OPERABLE UNIT NO. 13  
PHASE I RFI/RI WORK PLAN

**FIGURE 2-2**

**MASTER LEGEND**





IHSSs 117.1, 117.2, 128, 134, 158, 171, AND 186  
LOOKING SOUTH

OU132-4.DWG

OPERABLE UNIT NO. 13  
PHASE I RFI/RI WORK PLAN  
FIGURE 2-4  
U.S. DEPARTMENT OF ENERGY  
Rocky Flats Plant, Golden, Colorado

A non-radioactive waste site and a scrap metal disposal site were reported to have been uncovered during the excavation for the construction of the Protected Area in the early 1980s. It is estimated that the waste burial took place in the 1960s. The buried material included machine turnings, rings, shapes, overlays and other metal parts. It was not oily. Transformers may also have been disposed of at this site.

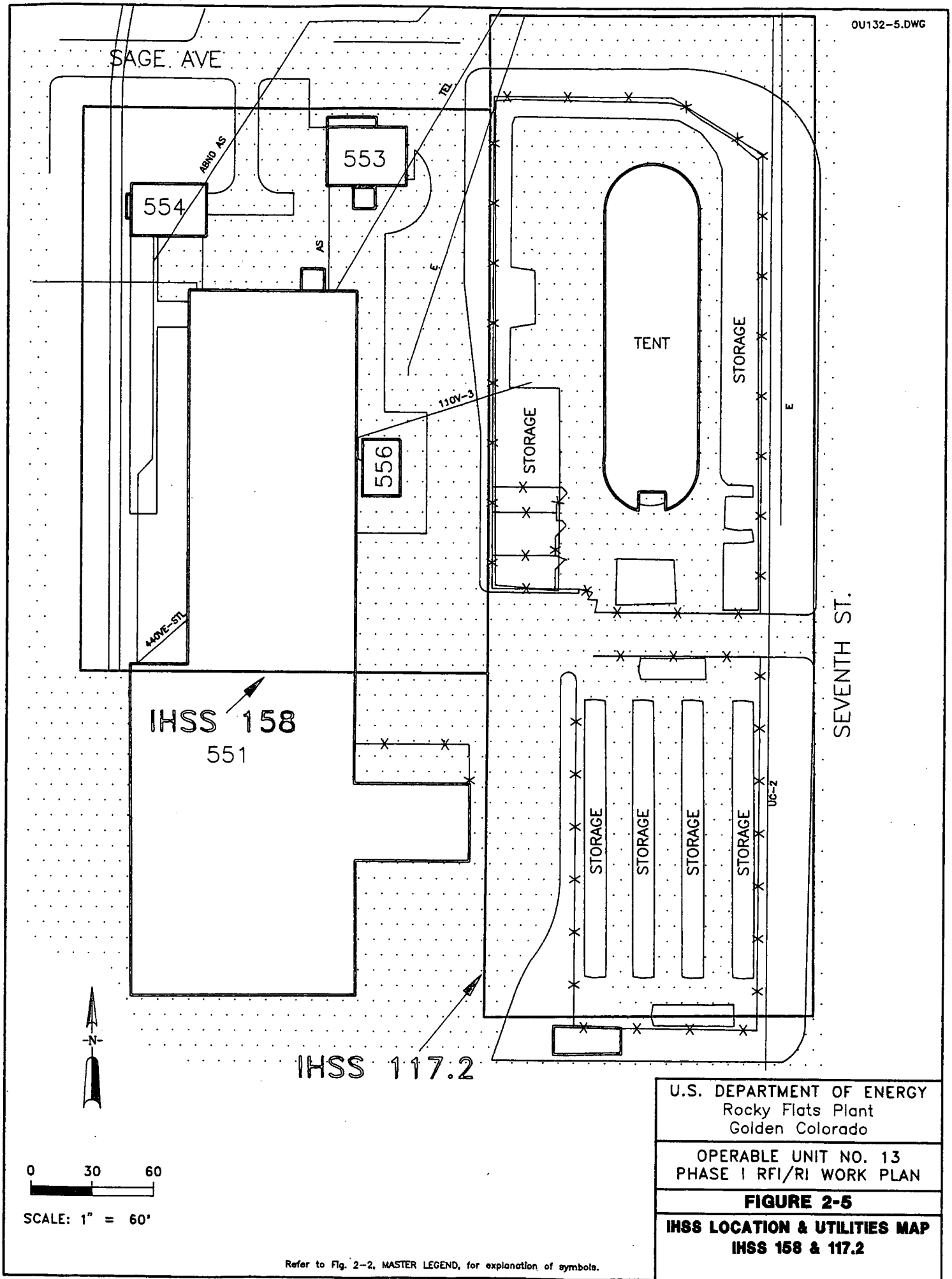
No documentation was found for any specific spills at this site.

#### 2.1.1.2 Middle Chemical Storage Site (IHSS 117.2)

IHSS 117.2 is located east of Building 551, south of Sage Street, and west of 7th Street (Figures 2-4 and 2-5). Presently, the area includes a large storage tent and outside storage. The area is paved.

Based on review of RFP photographs, the area was first used as storage some time prior to July 1954. The area was used as a multi-purpose storage facility until the early to mid-1970s, and was divided in the following manner: the northern 1/3 of the facility was used as warehouse storage; the middle 1/3 was used as a nonradioactive chemical storage facility; and the southern 1/3 was used as storage for pallets, cargo containers, and new drums. Material stored has included acids, soaps, solvents, drums of beryllium chips and turnings, drums of aluminum scrap, and drums of aluminum nitrate. The area was paved during the 1970s, probably in 1975. The present storage tent was built in 1990. The area is still used for storage purposes today.

Minor leaks and spills have occurred at the storage area. Routine monitoring of an aluminum scrap pile near Building 551, in 1959, indicated an occasional buildup of radioactivity. Uranium chips and turnings were found in an aluminum scrap pile near the Warehouse in 1963 and in



Refer to Fig. 2-2, MASTER LEGEND, for explanation of symbols.

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Golden Colorado

OPERABLE UNIT NO. 13  
PHASE I RFI/RI WORK PLAN

**FIGURE 2-5**

**IHSS LOCATION & UTILITIES MAP**  
**IHSS 158 & 117.2**



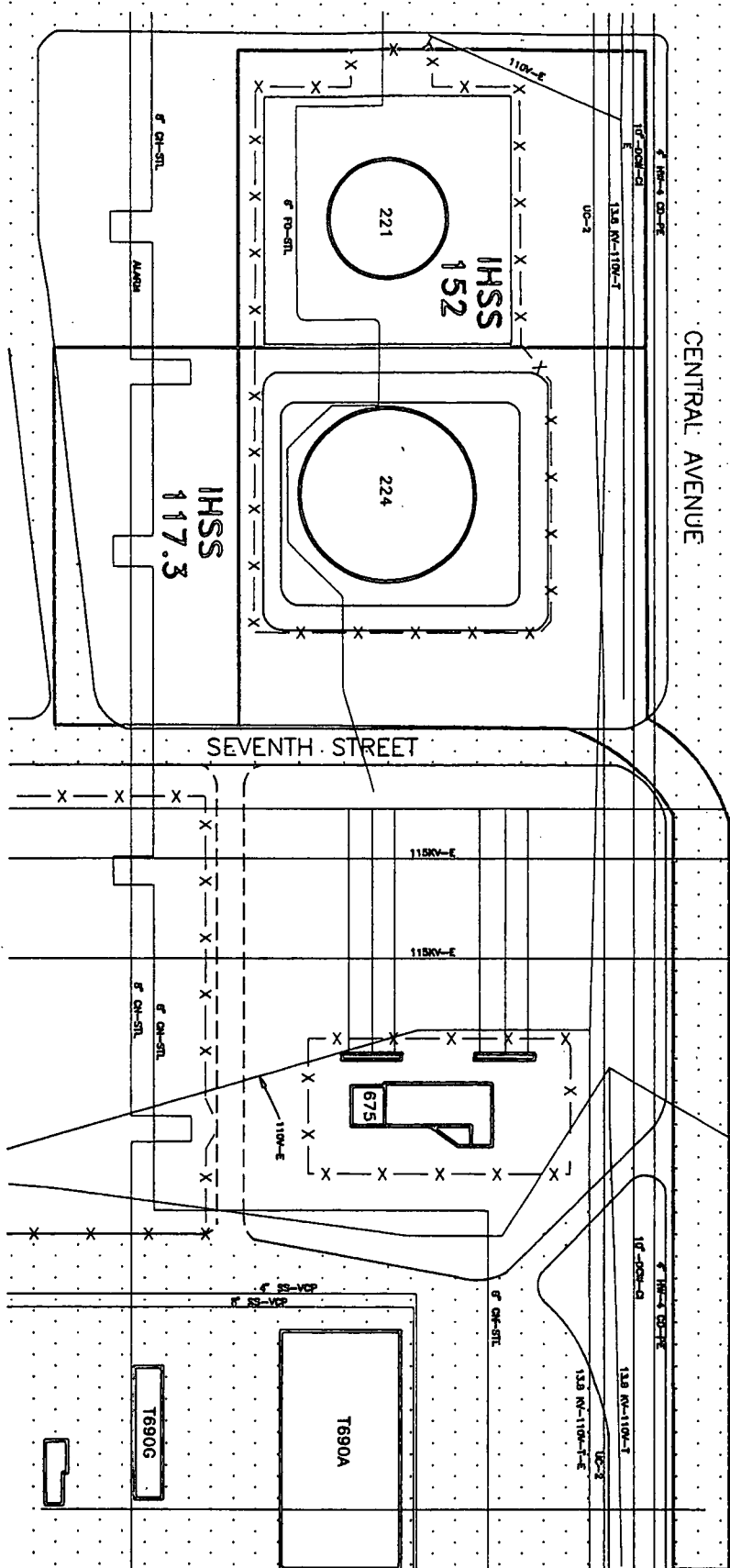
1964. In 1971 several drums of beryllium chips were found to be leaking an oily substance. In 1986, a 55-gallon drum of aluminum nitrate was punctured by a forklift near the east loading dock of Building 551. The liquid was reported to have flowed across a road (probably the driveway beside building 551) and to the east.

#### 2.1.1.3 South Chemical Storage Site (IHSS 117.3)

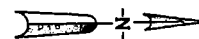
IHSS 117.3 is at the southwest corner of Central Avenue and Seventh Street. It was used for storage of various unidentified material from at least 1964 until 1970. Tank 224 was constructed on the site in 1973. The tank and its containment dike now cover most of the IHSS area (Figures 2-6 and 2-7).

Documentation has been found for only one release while the area was being used for storage. It is believed that a wooden waste box containing a glovebox was transferred from Building 776 to the storage area on May 4, 1965. Residual contaminated oil in the glovebox leaked out of the waste box. This was discovered after it arrived at the storage area. Highly contaminated oil had dripped onto the Central Avenue within 400 feet of the storage area and on the ground in the storage area where the box was placed.

The ground in the storage area that was contaminated during the glovebox incident, except for the area underneath the waste box, was removed on May 5 and 6, 1965. The glovebox was returned to Building 776 for investigation, decontamination, and repackaging. After an investigation, it was concluded that approximately 4 gallons of contaminated oil had gone undetected in the glovebox when it was originally placed in the waste box.



Refer to Fig. 2-2, MASTER LEGEND, for explanation of symbols.



A horizontal number line with tick marks at 0, 40, and 80. A shaded region starts at 0 and ends at 40.

SCALE: 1" = 80'

SCALE APPROXIMATE

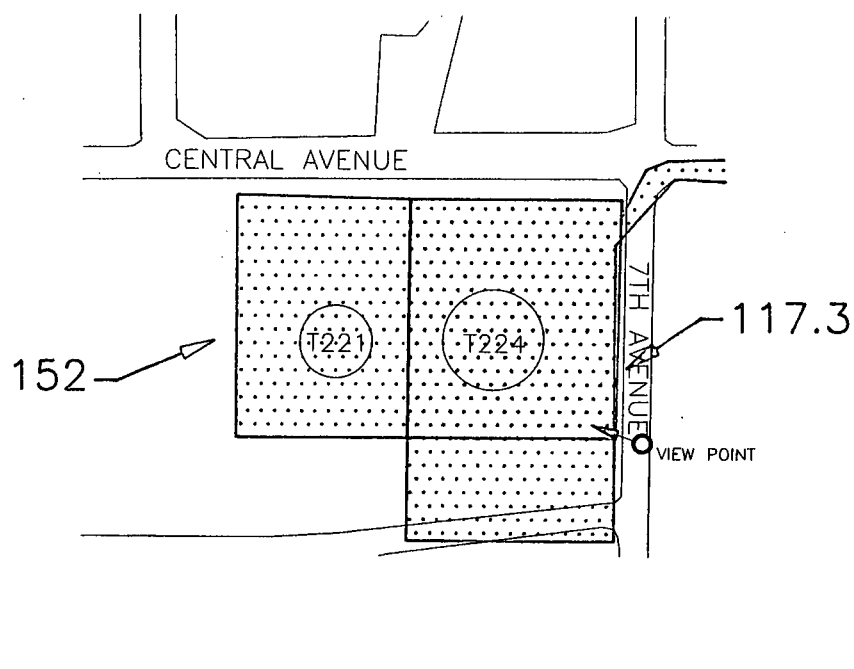
U.S. DEPARTMENT OF ENERGY  
Rocky Flats Plant  
Golden Colorado

OPERABLE UNIT NO. 13  
PHASE I RFI/RI WORK PLAN

FIGURE 2-6

## IHSS LOCATION & UTILITIES MAP

### IHSS 117.3 & 152



OU132-7.DWG

**PHOTOGRAPH 12**  
**IHSSs 117.3 AND 152**  
**LOOKING WEST NORTHWEST**

OPERABLE UNIT NO. 13  
 PHASE I RFI/RI WORK PLAN  
 FIGURE 2-7  
 U.S. DEPARTMENT OF ENERGY  
 Rocky Flats Plant, Golden, Colorado

#### 2.1.1.4 Oil Burn Pit No. 1 Waste Leak (IHSS 128)

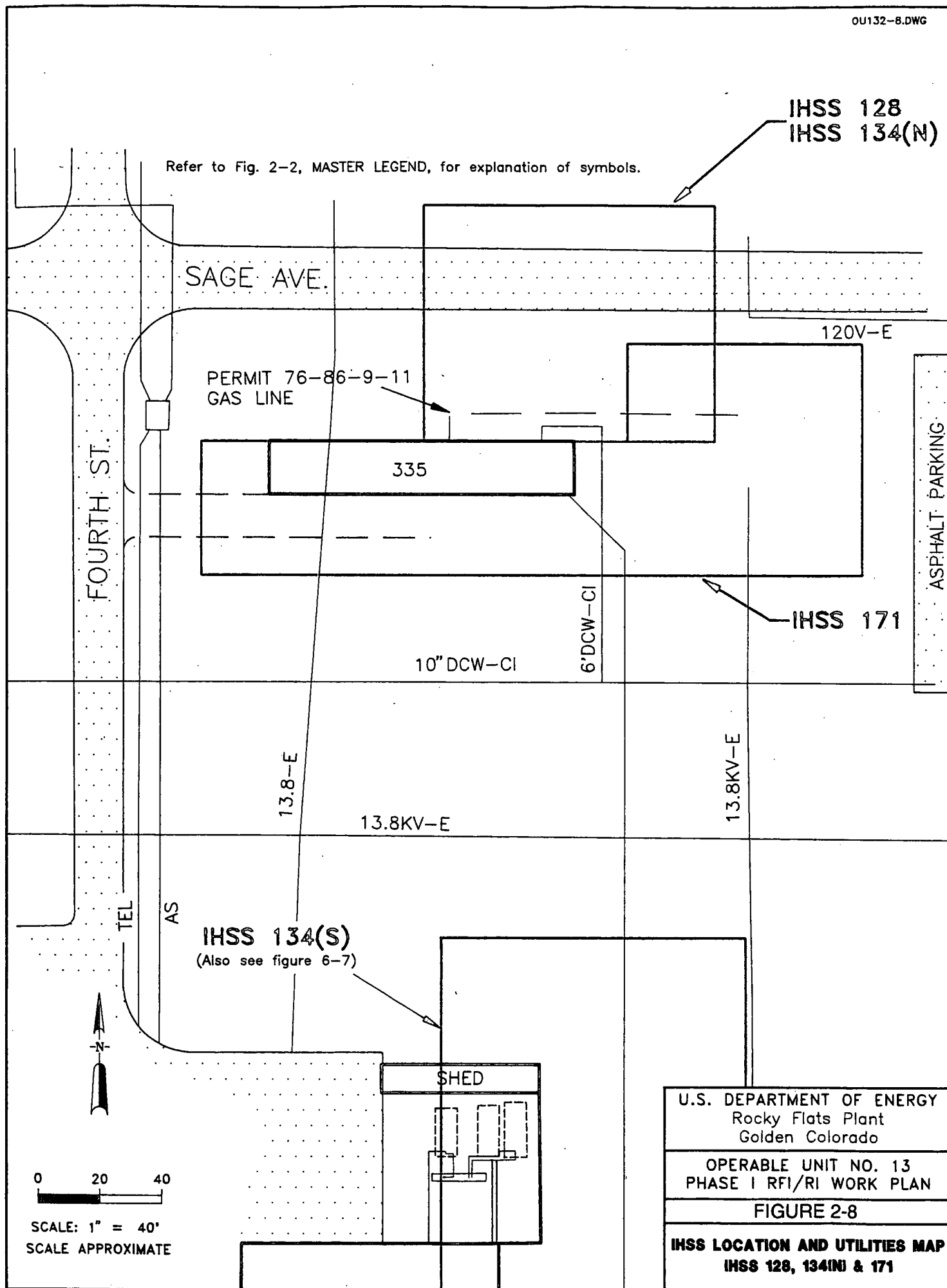
IHSS 128 is located north of Building 335 and beneath Sage Avenue, east of the Fourth Street intersection, (Figures 2-8 and 2-9). The site of the pit is buried. It was covered by fill used in the construction of Sage Avenue.

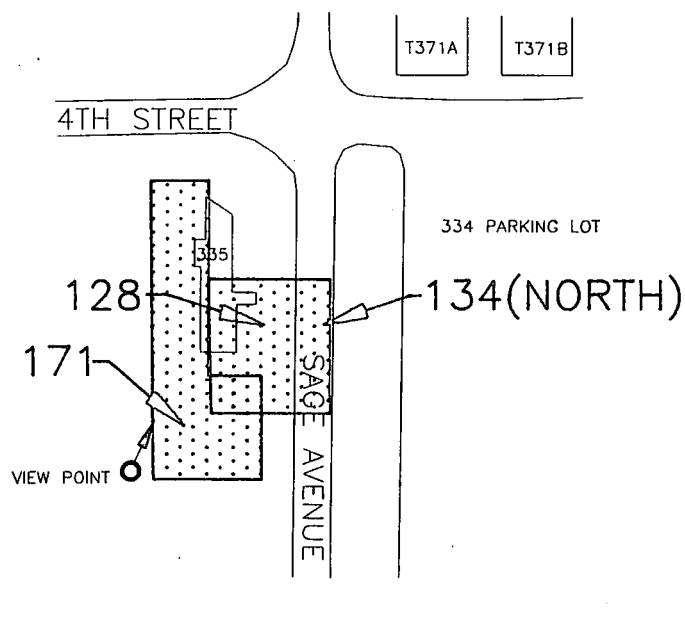
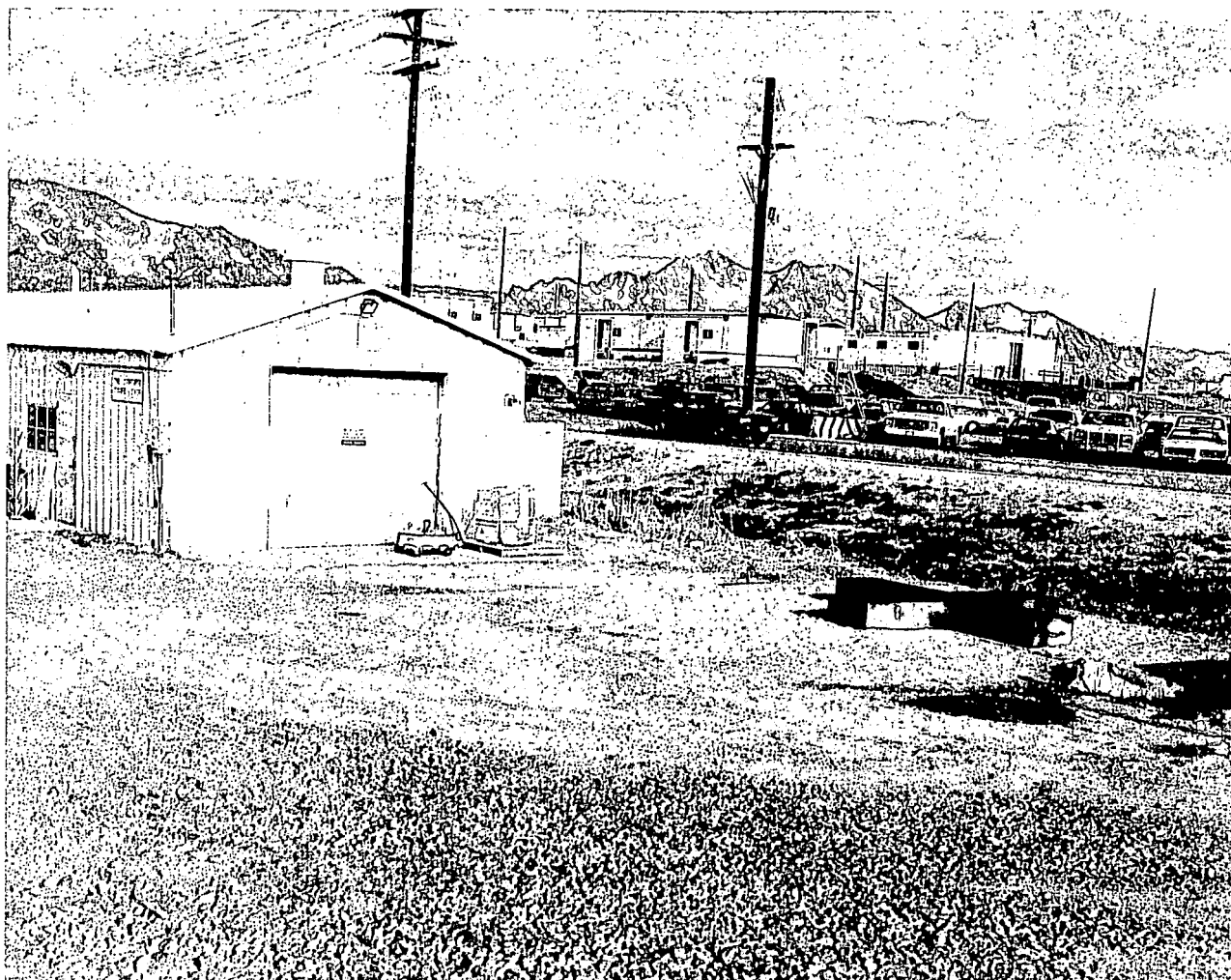
Approval was given by the Waste Disposal Co-Ordination Group and the Health Physics Department for experimental oil burning in July, 1956. A report issued on September 7, 1956, by the Health Physics and Medical Section Director summarized the experiment and concluded that the remainder of contaminated waste oil could be disposed of in a similar manner. Fourteen high-volume air samplers were placed in the area around the oil burn pit. Background air samples were taken. Approximately 200 gallons of contaminated oil were dumped into a shallow pit and ignited. It is likely that the oil was perchloroethene. The reported contaminant was depleted uranium. After the oil was burned, a few spots in the bottom of the pit registered as radioactive. The pit was backfilled. No dimensions were given for the pit.

The pit was referred to as the garage oil burning pit in the report on the experiment, suggesting that it pre-existed, and that disposal was taking place in the same location prior to the documented oil burning experiment.

#### 2.1.1.5 Lithium Metal Destruction Site (IHSS 134)

The Lithium Metal Destruction Site includes an area beneath an eastern addition of Building 331, an area that extends north of the east wing of Building 331 for about 250 feet, and the area beneath Sage Avenue that is the same as IHSS 128 (Figures 2-4 and 2-10). The east side of the L-shaped Building 331 houses the fire station and the west side is the vehicle maintenance

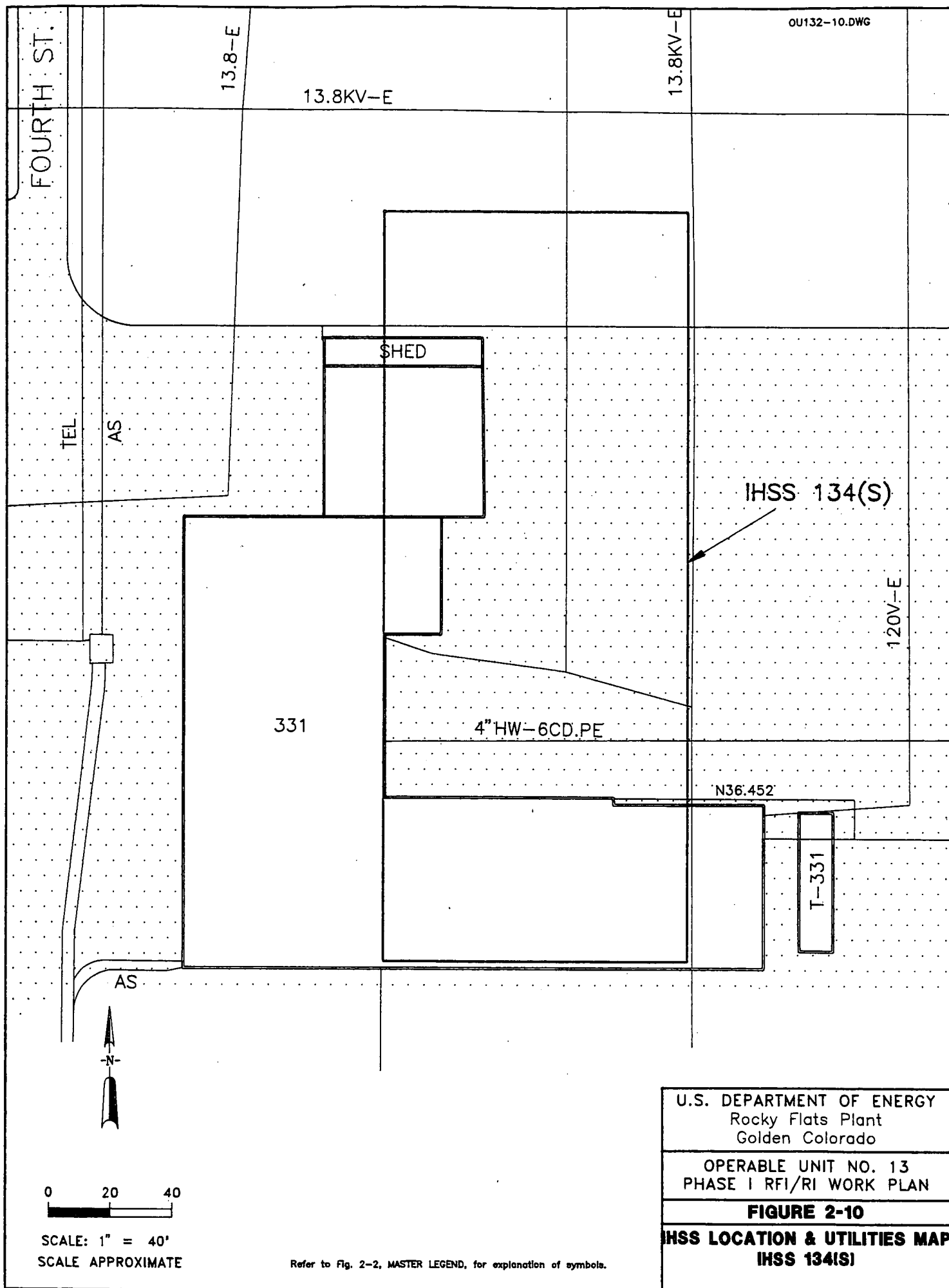




IHSS'S 128, 134(NORTH), AND 171  
LOOKING NORTHWEST

OU132-9.DWG

OPERABLE UNIT NO. 13  
PHASE I RFI/RI WORK PLAN  
FIGURE 2-9  
U.S. DEPARTMENT OF ENERGY  
Rocky Flats Plant, Golden, Colorado



garage. The area extending north of the east wing of the building is mostly paved and is used for parking and vehicle access. The small amount of unpaved area is not in its natural state.

The L-shaped Building 331 was built in 1952. About 1967 or 1968, the fire station was extended to the east and the area east of the building and the courtyard of the building were paved. The area beneath Sage Avenue is described under IHSS 128.

Lithium was introduced to the RFP in 1963 when lithium processing began in Building 444. Some forming and machining of lithium was also done in Buildings 777 and 881. The lithium was used in alkaline batteries, desiccants, ceramics, glazes, greases, soaps, and metallurgical applications. It was unlikely that the lithium was radioactively contaminated.

Buildings 444 and 881 personnel were able to dispose of their waste lithium, which was mixed with machining oils, by offering it to the fire station personnel for use in hand-held extinguisher training. The destruction of lithium near the fire station was done routinely from approximately 1963 until approximately 1966. Lithium coated with machining oils was brought to the fire station in shallow metal pans or one-gallon cans. The lithium was placed in a 55-gallon drum on the ground and the oil was burned off by lighting the mass on fire. The lithium was oxidized in the process. Lithium and oil would be burned in the same drum until that drum was full of ash and non-combustible residue. The disposition of the drum is uncertain but it was likely to have been sent to the landfill (Original Landfill - IHSS 115).

For fire-fighting training, the fire was extinguished by various methods. These methods may have caused some residue to be expelled from the drum onto the ground. This activity was in the area around the fire station, often close to the building on the east and south sides. Although most of the lithium destruction was done in the area very near to the building, some was done between Building 331 and the area east of Building 335. During the period of lithium destruction around Building 331, lithium was destroyed perhaps once every two to three months in quantities



of less than the contents of a one-gallon can. Two explosions that sprayed lithium around the area have been reported.

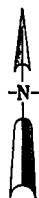
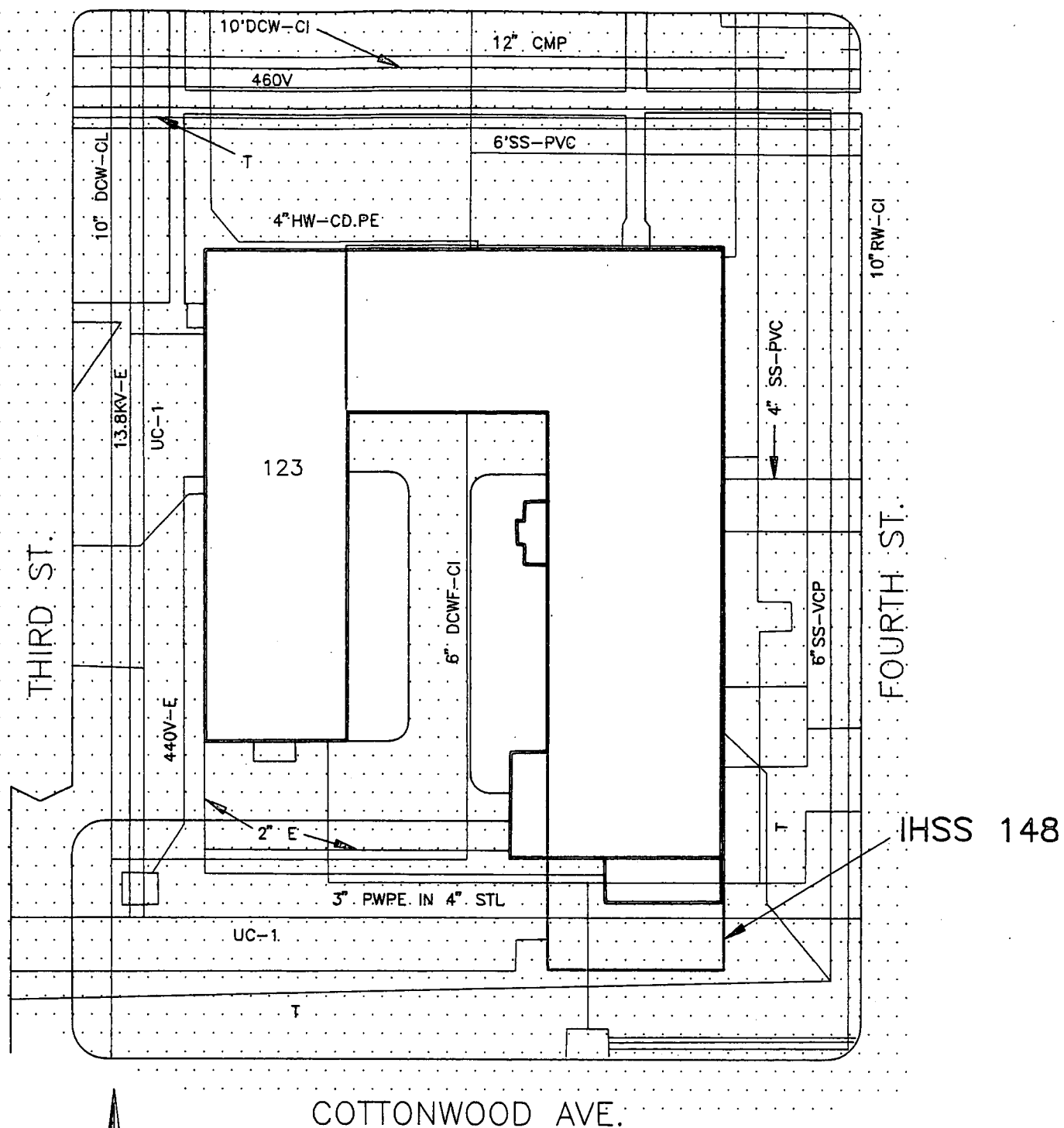
In 1979, a pipeline was installed from a gasoline tank at Building 331 to a sump east of Building 335, so the ground was disturbed from Building 331 to the sump. The gasoline tank replaced a tank that served pumps located along the south side of Building 331 close to the southwest corner.

Magnesium was also destroyed in the area. It is unlikely that the magnesium was radioactively contaminated. It was typically destroyed by burning in the area of the two ponds that is now beneath Sage Avenue. After the reaction was complete, the residue was left on the ground. This disposal was done in quantities of one or two 30-gallon drums about once each month. After 1966, the magnesium was burned in much smaller quantities (1-gallon cans). The smaller quantities were burned in pans and the residue probably scattered on the ground after the reaction was complete. In the 1970s, magnesium was burned in small quantities for fire training in the area behind Building 331.

#### 2.1.1.6 Waste Spills (IHSS 148)

Several small spills of nitrate-bearing wastes have been reported to have occurred around the outside of Building 123 (Figures 2-11 and 2-12). The building houses the health physics laboratories which analyze water, urine, soil, air, nose wipes, fecal material, and filter samples for the presence of plutonium, americium, uranium, radiation, tritium, beryllium, and organics. The building was constructed as a laboratory in 1953. When constructed, the building consisted of a north wing running east-west and an east wing running north-south. A west wing running north-south was added in the late 1960s, and an addition to the south end of the east wing was added in approximately 1972.

CENTRAL AVENUE



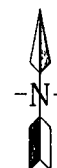
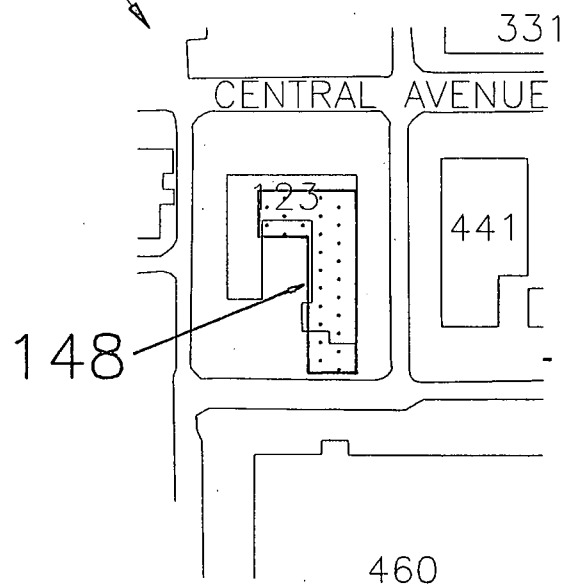
0 20 40

SCALE: 1" = 40'  
SCALE APPROXIMATE

Refer to Fig. 2-2, MASTER LEGEND, for explanation of symbols.



VIEW POINT



# IHSS 148 LOOKING SOUTHEAST

OU132-12.DWG

OPERABLE UNIT NO. 13  
PHASE I RF1/RI WORK PLAN  
FIGURE 2-12  
U.S. DEPARTMENT OF ENERGY  
Rocky Flats Plant, Golden, Colorado

The building is serviced with a process waste system that has always allowed for the collection of process wastes. The original process waste lines beneath the building were abandoned no later than 1975. They were constructed of a type of iron. The process waste lines that replaced the original lines were either double-contained or overhead lines.

The wastes from Building 123 may have contained radionuclides. The occurrence of small spills of nitrate bearing wastes, mentioned above, is based on reports by anonymous CEARP interviewees. No documentation of such spills has been found. Nitrate bearing wastes may also have been released from the original process waste pipeline buried beneath Building 123. The original process waste line drain was not double contained and varied in depth beneath the floor of Building 123 from approximately one-half foot to three feet beneath the bottom of the concrete floor. The line came out from beneath the south end of the east wing of the building, with an invert elevation of approximately 6032.5 feet. It has been stated by recent interviewees that this line, being constructed of iron, probably leaked considerable amounts of waste without personnel being aware of the leak. However, no leakage has been documented. The process waste line piping in the west wing, being newer, has never included the use of an iron pipe directly in contact with soils.

#### 2.1.1.7 Fuel Oil Tank (IHSS 152)

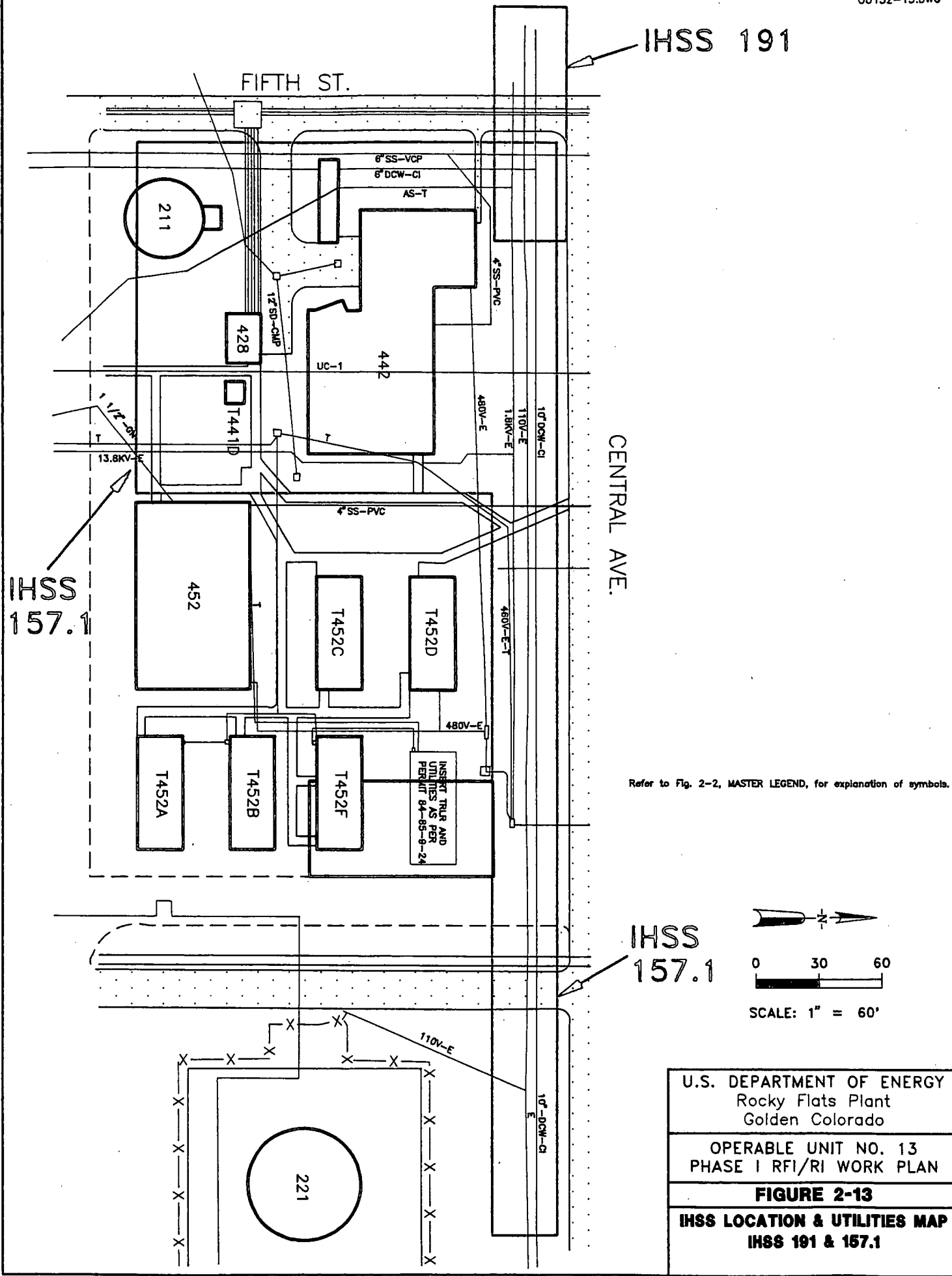
Tank 221 is an 800,000-gallon fuel oil storage tank located east of Building 452 (Figures 2-6 and 2-7). The tank was probably installed sometime in late 1955 or early 1956. It was originally constructed with a 10-foot high 140-foot by 140-foot earthen berm surrounding it. The tank contains fuel oil for use in RFP's central steam plant when natural gas is not available. This tank and the neighboring Tank 224, which is used for the same purpose, were noted as having spills on several occasions. Tank 224 holds approximately 1,800,000 gallons and was constructed sometime in the last half of 1973.

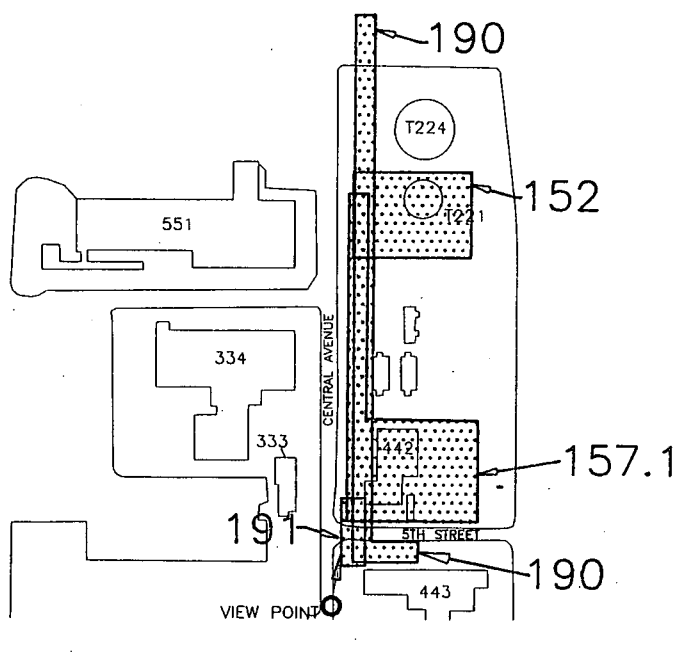
On January 29, 1971, No. 6 fuel oil leaked from the open end of the hose used to transfer the oil from a transport truck to Tank 221. The open end of the transfer hose was outside of the west berm so the oil flowed into the storm drainage ditch. Approximately 700 gallons of fuel oil leaked to the ditch, which runs just outside the tank berm on the west and north sides of the tank. Photographs show the oil barely seeping under a gravel dike, which had been placed to prevent the spill from entering the drainage pipe under Seventh Street. There is no evidence that the oil did reach this pipe. Trenches were dug to contain the spill and direct it to the open area east of Tank 221. After the spill had been contained, the contaminated soil was excavated and buried in the on-site landfill (IHSS 114). A similar incident is said to have occurred in the six months prior to this incident, but it is not documented.

Other spills have occurred at the tanks. On April 4, 1975, a fuel oil leak of unspecified volume occurred. This leak probably occurred at Tank 221 into the bermed area surrounding the tank. During the week ending February 16, 1979, approximately 400 gallons of No. 6 fuel oil were spilled during the transfer of oil to the tanks (specific tank not mentioned). Cleanup of the oil contained in the berm from this spill was planned but no documentation of actual cleanup was found.

#### 2.1.1.8 North Area Radioactive Site (IHSS 157.1)

Building 442 was constructed in 1952 and served as a laundry facility until approximately 1972 when it was converted to a filter test laboratory. The building is located at the southeast corner of Fifth Street and Central Avenue, (Figures 2-13 and 2-14). Building 442 was expanded to its current size in the mid-1980s. As a laundry, the building received contaminated clothing from Buildings 444 and 883 and non-contaminated clothing from other areas of the plant site. Building 444 handled depleted uranium and later beryllium. Beryllium was introduced to the RFP in the early 1960s. Historical accounts reference the laundry building as being potentially affected by radionuclides and chemical materials. The notable constituents were depleted





IHSSs 152, 157.1, 191, AND PART OF 190  
LOOKING EAST

00132-14.DWG

OPERABLE UNIT NO. 13  
PHASE I RFI/RI WORK PLAN  
FIGURE 2-14  
U.S. DEPARTMENT OF ENERGY  
Rocky Flats Plant, Golden, Colorado

uranium and beryllium with at least one incident involving enriched uranium. The soil around the building was affected by radioactive releases. The laundry operations were water based (not solvent based). One incident involved a leak or spill from a barrel stored outside of the building. Liquid from the barrel reportedly traveled in the Central Avenue ditch as far as Building 551. Contamination around Building 442 has been identified as resulting from the laundry operations and not from the activities that have occurred since approximately 1972. At that time, filter testing replaced laundry operations as the function of the building. No documentation was found which indicated that the activities of the filter testing laboratory resulted in any releases of contaminants to the environment.

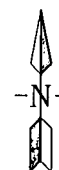
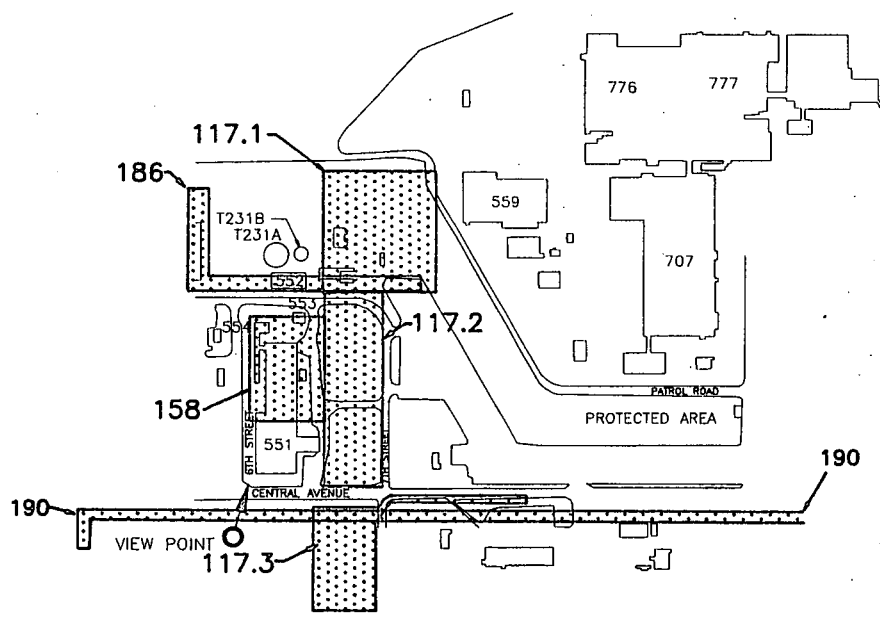
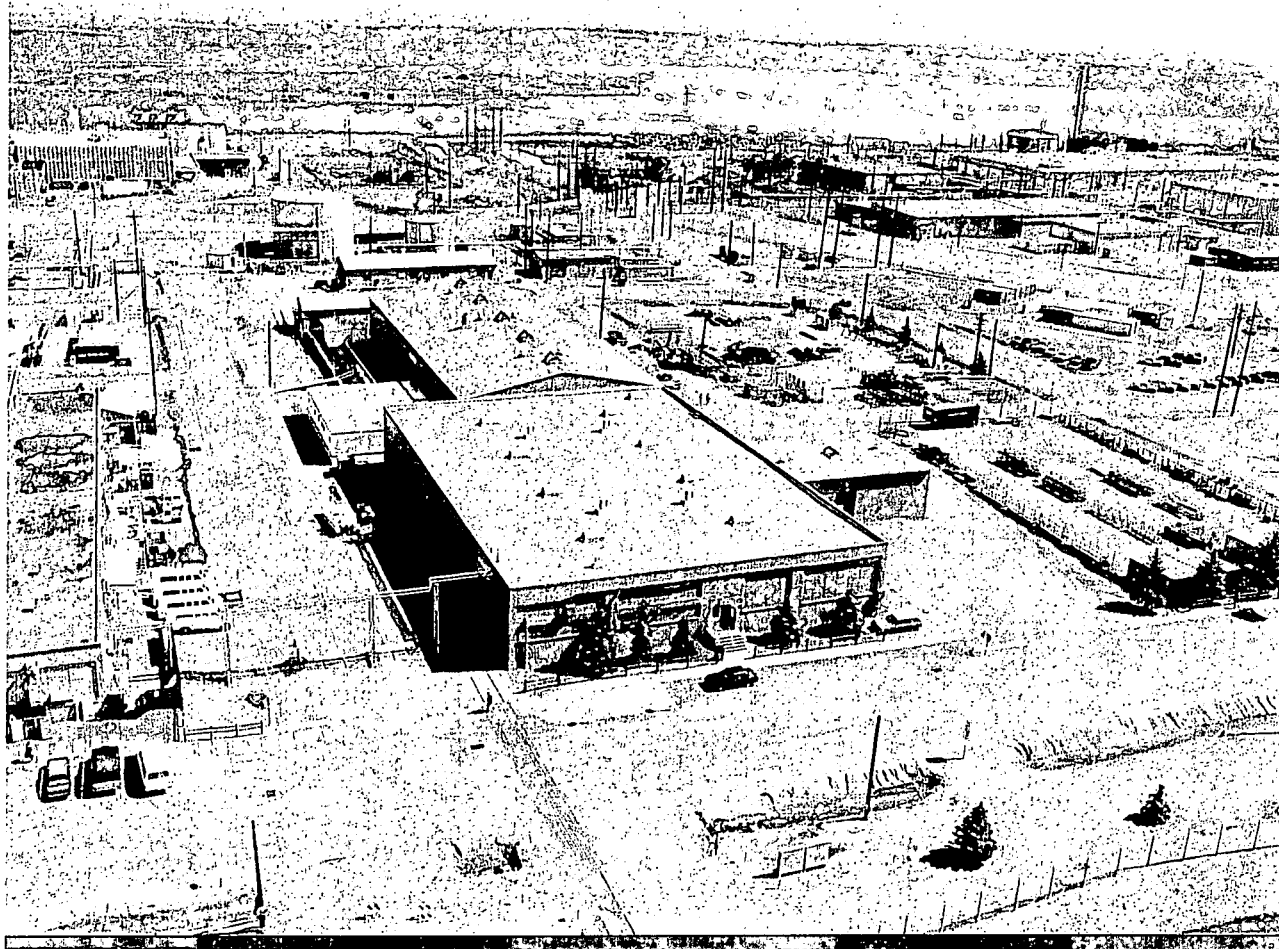
#### 2.1.1.9 Building 551 Radioactive Site (IHSS 158)

Historical accounts reference the area north of Building 551 (Figures 2-5 and 2-15) as potentially being contaminated from leakage of waste boxes loaded into railroad container cars. Building 551 was among the initial RFP structures. The building has served as the RFP warehouse since 1952. The original building only occupied the southern portion of the current building, having been more than doubled in size during two expansion periods. The area has been disturbed and regraded several times during subsequent construction activities.

Building 551 was and is used as a centralized location for the receipt and distribution of various supplies from vendors. Supplies include all types of products that are used at RFP from paper and office equipment to motor oil and other chemicals. On occasion, small quantities of waste materials contaminated with low levels of uranium from Building 444 were brought to the warehouse and stored in a cage while manifests were prepared for offsite shipment. These materials were reportedly transported in small containers or drums.

Building 554, which is within the boundary of this IHSS, was used as a loading dock for off-site shipments by train. The building was originally constructed in 1952. A steel grate platform was





IHSSs 117.1, 117.2, 158, 186, AND PARTS OF 117.3 AND 190  
LOOKING NORTH NORTHEAST

OU132-15.DWG

OPERABLE UNIT NO. 13  
PHASE I RFI/RI WORK PLAN  
FIGURE 2-15  
U.S. DEPARTMENT OF ENERGY  
Rocky Flats Plant, Golden, Colorado

constructed in 1965 and leads south from Building 554 parallel to Building 551. It is approximately 150 feet long and 12 feet wide and was used for storage prior to shipment by train. It is currently used for storage.

Prior to 1965, the yard between Buildings 551 and 554 was used occasionally for storage overflow from the warehouse. The area considered potentially contaminated from the Building 554 storage and loading activities is located in and around the building, between Buildings 551 and 554, and around the loading platform.

It has been reported that leakage of waste boxes from the fire (unstated whether it was the 1957 or 1969 fire) occurred while the boxes were loaded onto a train. Residual radioactive contamination may have occurred.

The area considered potentially contaminated from the Building 551 warehouse activities that occurred prior to 1965 is now located beneath the north wing. The north wing of Building 551 has been used by construction contractor J.A. Jones for the fabrication of sheet metal products since about 1990.

#### 2.1.1.10 Waste Peroxide Drum Burial (IHSS 169)

The establishment of this IHSS resulted from a reference in RCRA 3004(u) dated November 28, 1986. The report discusses the burial of a 55-gallon hydrogen peroxide drum in the chemical storage area east of Building 551. A thorough search of plant records (listed in Appendix A) failed to find any additional references to this incident. However, as details of the hydrogen peroxide spill described in Section 2.1.1.14 IHSS 191 were compared, it became clear that the events were quite probably confused. IHSS 191 describes a hydrogen peroxide spill at the intersection of 5th Street and Central Avenue. Details from this spill are more fully documented,

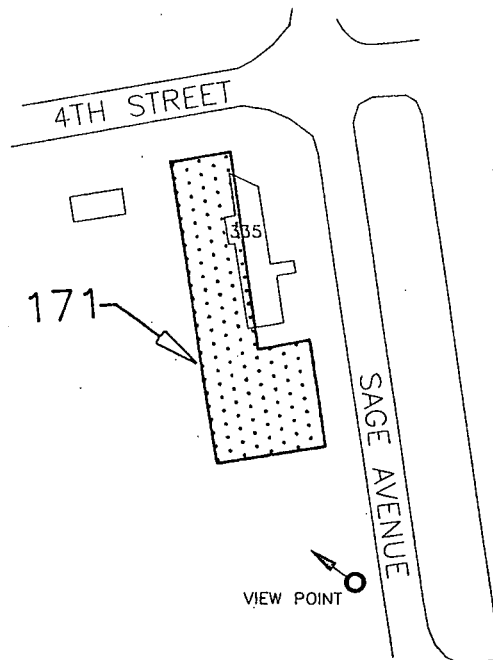
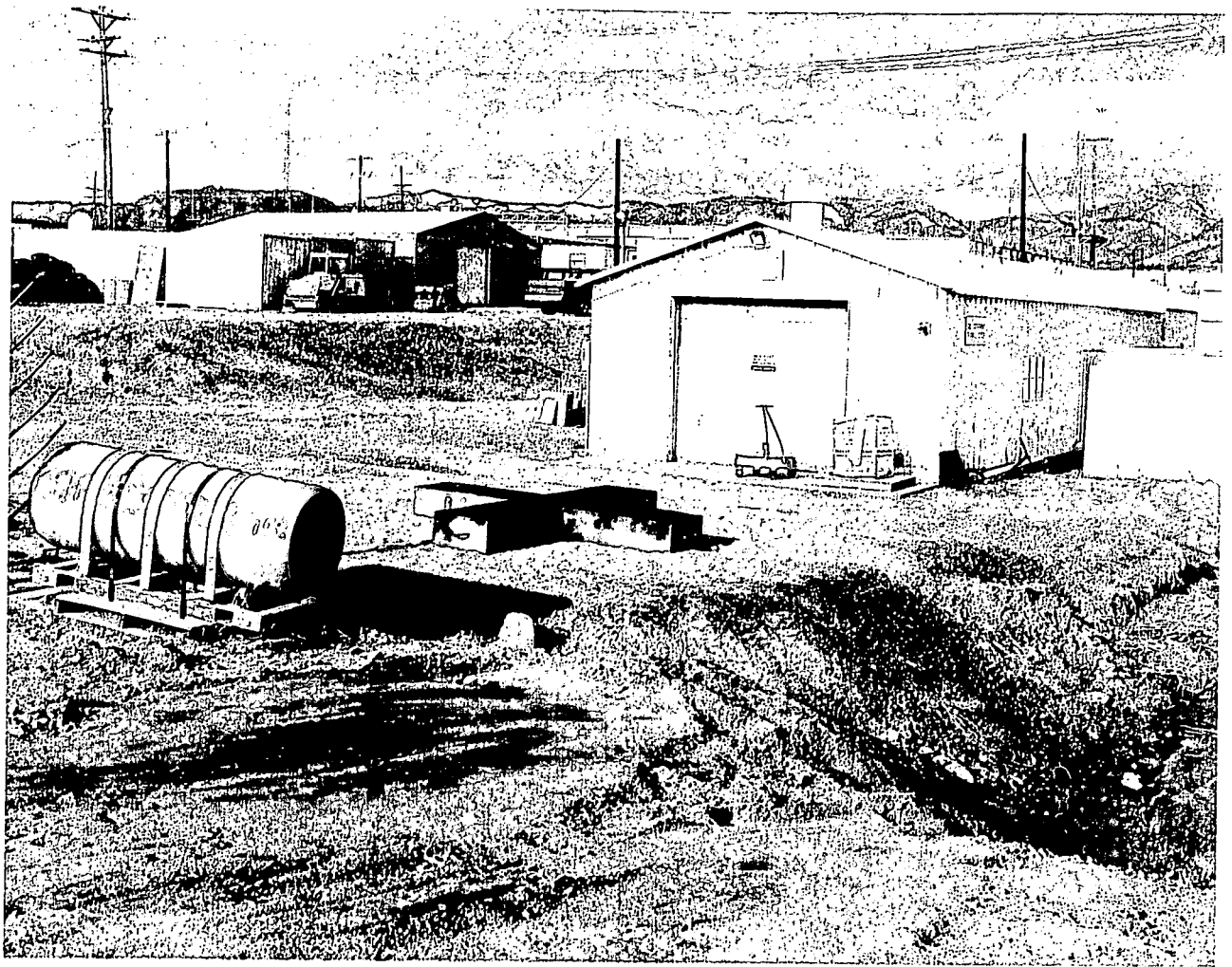
and the similarities of occurrence with the RCRA reported spill above give credence to the probability that the two events are confused.

If the drum burial occurred at all, it probably occurred between the fall of 1985 when most of the data gathering for CEARP Phase I was curtailed and November 1986 when the RCRA 3004(u) document was prepared. However, the area where the drum was supposed to have been buried was paved over in 1975. It is unlikely that any drum would have been buried in an already paved area. Of course there is always the possibility that the event could have occurred prior to pavement (i.e., prior to 1975), but there are no records of any other similar incidents taking place prior to the 1986 RCRA 3004(u) report. In addition, interviews with warehouse and fire protection personnel indicated that only one event took place which is consistent with the details reported in the description of IHSS 191 (See Section 2.1.1.14).

Regardless of whether the events were confused or not, the spill of 55 gallons of hydrogen peroxide at least 6 years ago does not represent a threat to human health or the environment. A review of the literature indicates that  $H_2O_2$  is not a particularly hazardous material and there is no evidence that it persists in the environment. In fact, when spilled,  $H_2O_2$  reacts very quickly with dirt to form  $O_2$  and  $H_2O$  which are not hazardous products of reaction. Any traces of this event would have disappeared long ago. We feel that the documentation presented is sufficient to support a no further action justification by the agencies in the record of decision.

#### 2.1.1.11 Solvent Burning Ground (IHSS 171)

Building 335 (Figures 2-8 and 2-16) has been used in the past and is still used to some degree for training of fire department personnel. The yard to the east of the building was used to practice extinguishing fires with various hand-held extinguishers. The area is now used infrequently for this purpose.



OU132-16.DWG

IHSS 171  
LOOKING WEST SOUTHWEST

OPERABLE UNIT NO. 13  
PHASE I RF1/RI WORK PLAN  
FIGURE 2-16  
U.S. DEPARTMENT OF ENERGY  
Rocky Flats Plant, Golden, Colorado

Outdoor firefighting training occurred in the area to the east of the building from approximately 1969 through 1990. Outdoor types of training included the use of a large cross-shaped pan or a smaller square pan in which diesel fuel was burned and then extinguished. Most of the fuel was burned during the process although some was allowed to remain in the pan and would then mix with rainwater. The pans of fuel and rainwater were dumped on the ground. An inspection was conducted on December 11, 1990 by RFP Clean Water Act Division (CWAD) personnel. The large cross-shaped pan was found to have holes in it and oil contaminated soil was present around the pans. Small amounts of magnesium may have been used to ignite the diesel fires. Past training has included the use of a "tree" constructed of metal that allows propane to escape from the "branches" of the tree. A large quantity of water was used during this process and the water was allowed to flow into the storm drain. The propane tank used to fuel the tree is located north of Building 335.

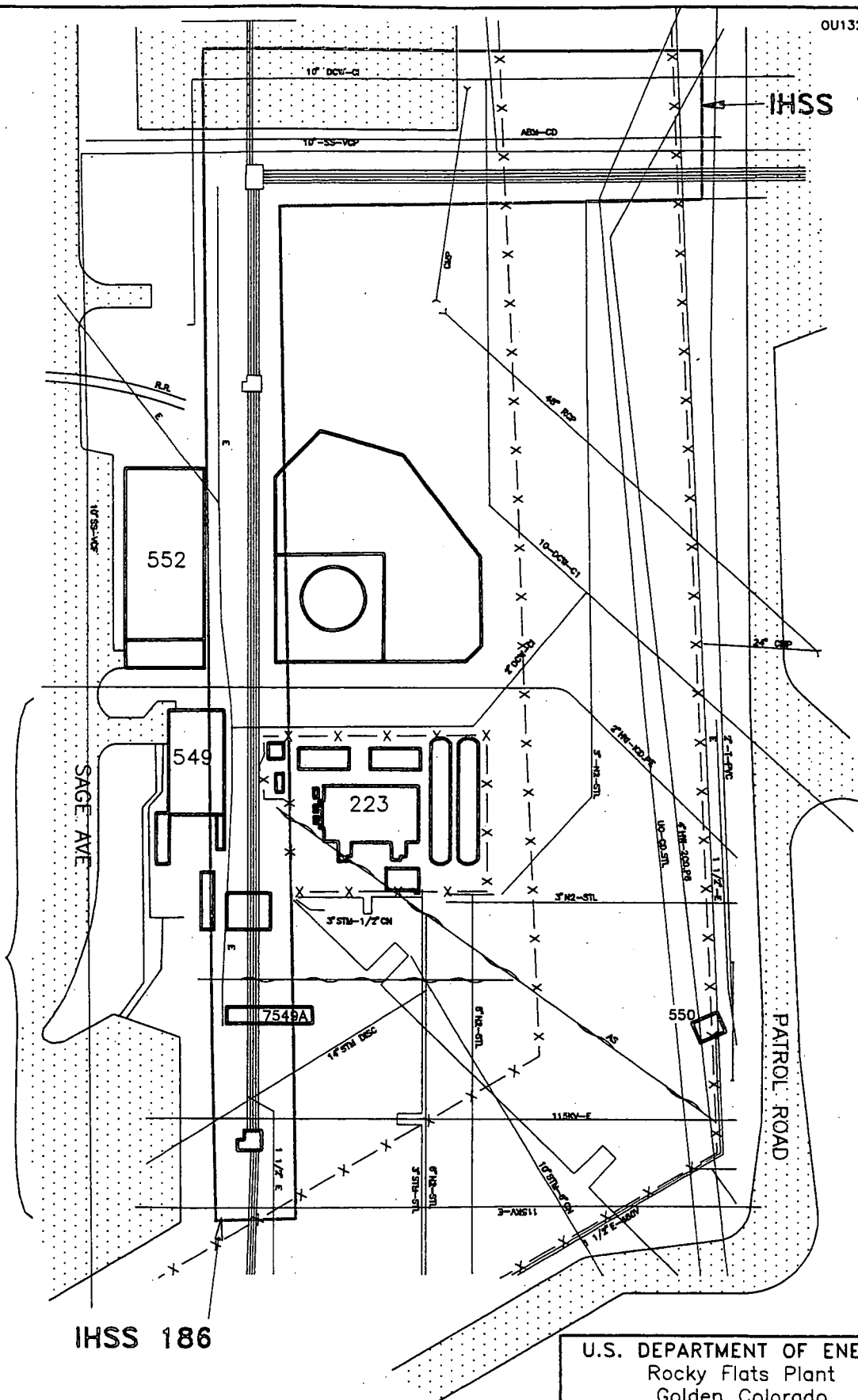
An open sump is located in the area and consists of an approximately 2-foot section of corrugated pipe over a square concrete sump of unknown depth. Both the pipe and the concrete have grates over them. There has been standing water visible in the sump during site visits in November 1991, December 1991, and March 1992, and the water has had a sheen on the surface at every visit. The water surface is approximately 2 feet below the top of the sump. The sheen in the sump may have come from the gasoline tank on the north side of Building 331 since the sump is part of the french drain for the tank. The tank and sump were installed in 1979. The sump is located in the center of the fire training area but has no connection with the training activities. The only materials used in fire training were diesel fuel, gasoline, and propane.

#### 2.1.1.12 Valve Vault (IHSS 186)

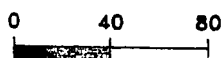
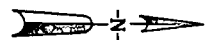
Valve Vault 12 is part of the existing process waste system. It is located west of Building 552 (a gas cylinder storage facility), east of a paved parking lot, south of the Protected Area, and north of the intersection of Sixth and Sage Streets (Figures 2-17 and 2-18). Valve Vault 12

IHSS 186

SOIL GAS & SURFACE  
RADIOLOGICAL SURVEY  
WILL BE DONE AS PART  
OF IHSS 117.1 SURVEY



IHSS 186



SCALE: 1" = 80'  
SCALE APPROXIMATE

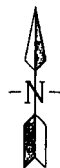
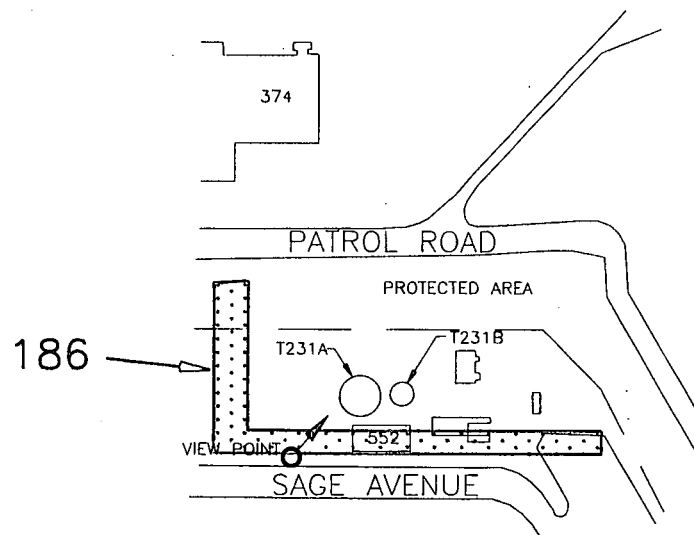
Refer to Fig. 2-2, MASTER LEGEND, for explanation of symbols.

U.S. DEPARTMENT OF ENERGY  
Rocky Flats Plant  
Golden Colorado

OPERABLE UNIT NO. 13  
PHASE I RFI/RI WORK PLAN

**FIGURE 2-17**

**IHSS LOCATION & UTILITIES MAP  
IHSS 186**



**IHSS 186**  
**LOOKING NORTH NORTHEAST**

OU132-18.DWG

OPERABLE UNIT NO. 13  
 PHASE I RFI/RI WORK PLAN  
 FIGURE 2-18  
 U.S. DEPARTMENT OF ENERGY  
 Rocky Flats Plant, Golden, Colorado

extends approximately 20 feet below the ground surface and has plan-view dimensions of 15.5 feet by 12.3 feet. It contains pumps, transformers, breakers, switches, and a sump pump. The location of Valve Vault 12 can be identified by an above-ground structure. Valve Vault 13 is west of Valve Vault 12 and Building 231. It contains pumps and valves for two adjacent tanks.

The outline of the IHSS is elongated because it follows an OPWL that leaked. The area covered by the IHSS in this report differs from that in the HRR. The boundary given in the HRR was displaced from the location of the OPWL. Consequently, it was necessary to correct the boundary in this Work Plan.

The pipe leak was discovered on October 24, 1986 in the excavation for the pump house located just southwest of the process waste tanks. The soil was excavated back to a failure in the pipeline between Valve Vault 12 and Valve Vault 13. Uranium nitrate (identified by process knowledge) had apparently seeped out along the bedding material of the pipeline and into the excavation. In response to the release, the area was excavated. All of the soil surrounding Valve Vault 12 was excavated, and the excavation extended approximately 18 feet west of the valve vault. Soil under the pipeline was removed and an underground concrete structure which supported a roadway going over a ditch at that time was excavated. The release occurred at an elevation approximately 7 to 8 feet below the ditches which dissect the area.

By November 21, 1986, the line between Valve Vaults 12 and 13 was replaced. Radiation surveys of the area at that time indicated low-level residues. Cleanup was deemed complete on December 8, 1986 with radiation in the area only slightly above background.

Process waste may contain a large range of constituents. Soil and water sampling done at the time of the incident indicates the presence of alpha and beta radiation, uranium, and americium. Chloride and sulfate were detected. The exact quantity of released process waste is unknown; however, one reference states that the soil was saturated with a yellow liquid.

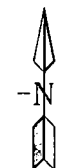
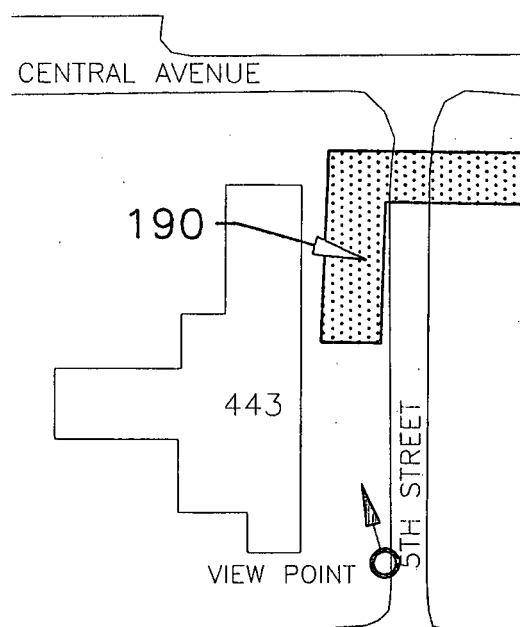
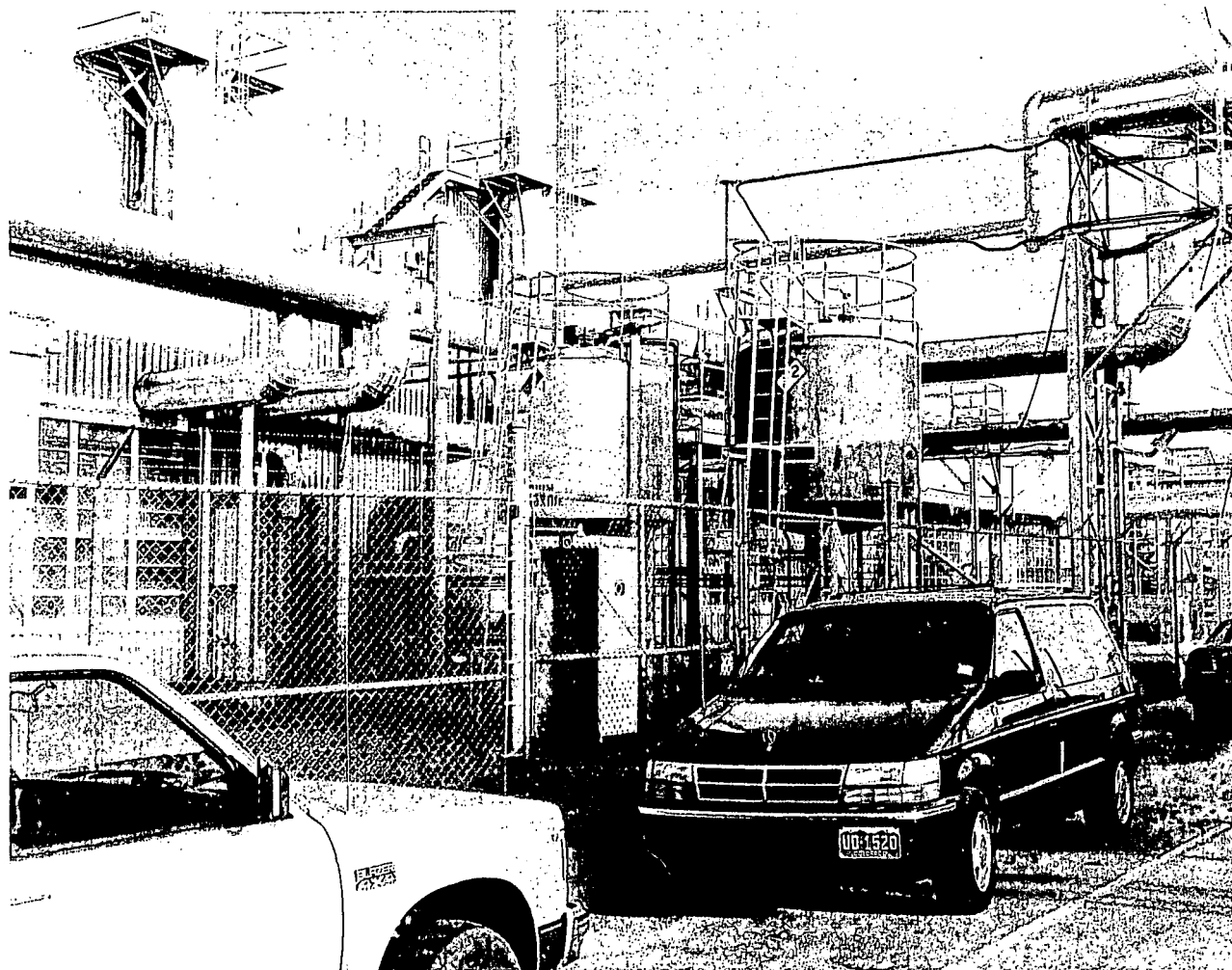


Another incident, which occurred on October 21, 1989, may also have impacted the vicinity of Valve Vault 12. According to the Critique Report of the Unplanned Event Preliminary Investigation on the incident, Valve Vaults 11, 12, and 13 were flooded with approximately 10,000 gallons of solar pond water. The cause of the incident was the separation of a pipe joint outside of Valve Vault 12 during a routine transfer of solar pond water. At the time of the incident, the sensor alarms were not operating because of construction activities. The problem was identified during a scheduled visual surveillance, at which time a large amount of liquid was found in the valve vaults. All other transfers were curtailed, and the liquid was pumped from the valve vaults and put in Tank 231B.

#### 2.1.1.13 Caustic Leak (IHSS 190)

Two documented releases from a caustic storage tank (Figure 2-19) located near the southeast corner of Building 443, the steam generation plant, resulted in establishing the IHSS 190. The tank is an aboveground, steel, 3,000-gallon tank which is used for concentrated sodium hydroxide (caustic) storage. The secondary containment of the tank is a 3,000-gallon holding basin. The 50 percent sodium hydroxide solution is raw product, as opposed to waste product, and is used for cleaning purposes in Building 443. The documented releases occurred as described below:

- 1) On December 3, 1978, approximately 1,500 gallons of caustic leaked at an approximate rate of 0.5 gallons per minute from the lower flange area of the tank into the holding basin. An operator drained the holding basin through a ball valve, thinking that the liquid was snow runoff and condensate. The next day, it was realized by personnel that the liquid released was actually sodium hydroxide and not condensate and snowmelt. The holding basin again contained approximately 1,500 gallons of liquid (the remaining contents of the tank), with a pH of 14. An investigation was conducted on the drainage ditches. Repairs were made on the tank. The caustic which had been contained in the holding basin was pumped into Building 443 and handled as process waste.



OU132-19.DWG

# PART OF IHSS 190 LOOKING NORTH NORTHWEST

OPERABLE UNIT NO. 13  
PHASE I RFI/RI WORK PLAN  
FIGURE 2-19  
U.S. DEPARTMENT OF ENERGY  
Rocky Flats Plant, Golden, Colorado

It was determined that sodium hydroxide was present in the Central Avenue Drainage Ditch. Flow from this ditch was routed to Pond B-1 for containment. Additional surface water which would typically flow to the Central Avenue Ditch or Pond B-1 was diverted away from the ditch and to Pond B-3. At this time, normal flow of the Central Avenue Ditch was to Pond B-1 and then to Pond B-3. Pond B-2 was used for spill control and laundry water containment.

To neutralize the water in the ditch, 5,000 pounds of alum was spread along the Central Avenue Ditch between 5th and 10th Streets during the week of December 15, 1978.

(Alum reacts with water to become sulfuric acid, thereby reducing the pH. By March 16, 1979, the water in Central Avenue Ditch was at an acceptable pH for discharge into Walnut Creek. It is assumed that the released water entered South Walnut Creek through the normal route of Central Avenue Ditch to Pond B-3 to Pond B-4 and out to South Walnut Creek.

Neutralization of Pond B-1 was attempted by the addition of 1,400 pounds of alum within 5 days of the occurrence. During the week of December 8, 1978, the water in Pond B-1, which contained some of the sodium hydroxide, was pumped to Solar Pond 207B-North. On April 24, 1979, water from the spill which had been stored in Solar Pond 207B-North was transferred to Ponds B-2 and A-2. These ponds, at that time, were used for containment and evaporation of laundry effluent. By June 29, 1979, the remaining water from the caustic spill was sprayed on the hillside adjacent to Pond B-1, because it was found to be environmentally acceptable.

Due to successful use of Pond B-1 for spill control, on December 8, 1978, normal flow from the Central Avenue Ditch began to flow directly to Pond B-3, and Ponds B-1 and B-2 were both isolated for spill control.

2) Another spill occurred from the sodium hydroxide tank on January 6, 1989. Approximately 1 to 3 gallons of caustic spilled in to the holding basin, where it was contained. Because the liquid was contained in the secondary containment, there was no release to the environment. It is probable that the caustic in the holding basin was pumped into Building 443 and handled as process waste in the same manner as the contained liquid in the 1978 incident.

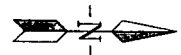
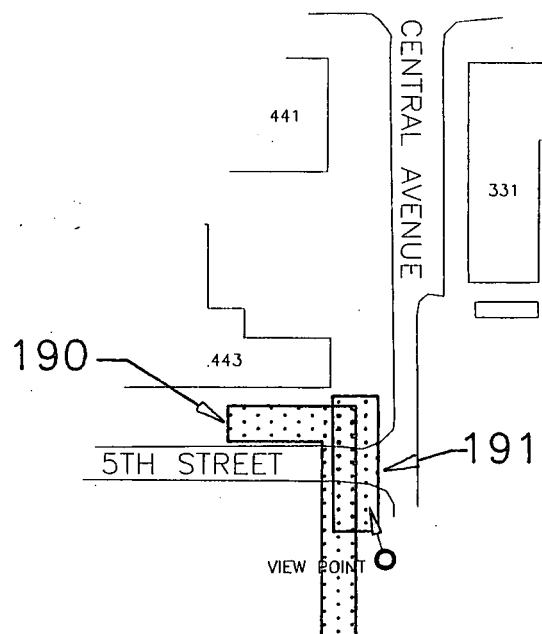
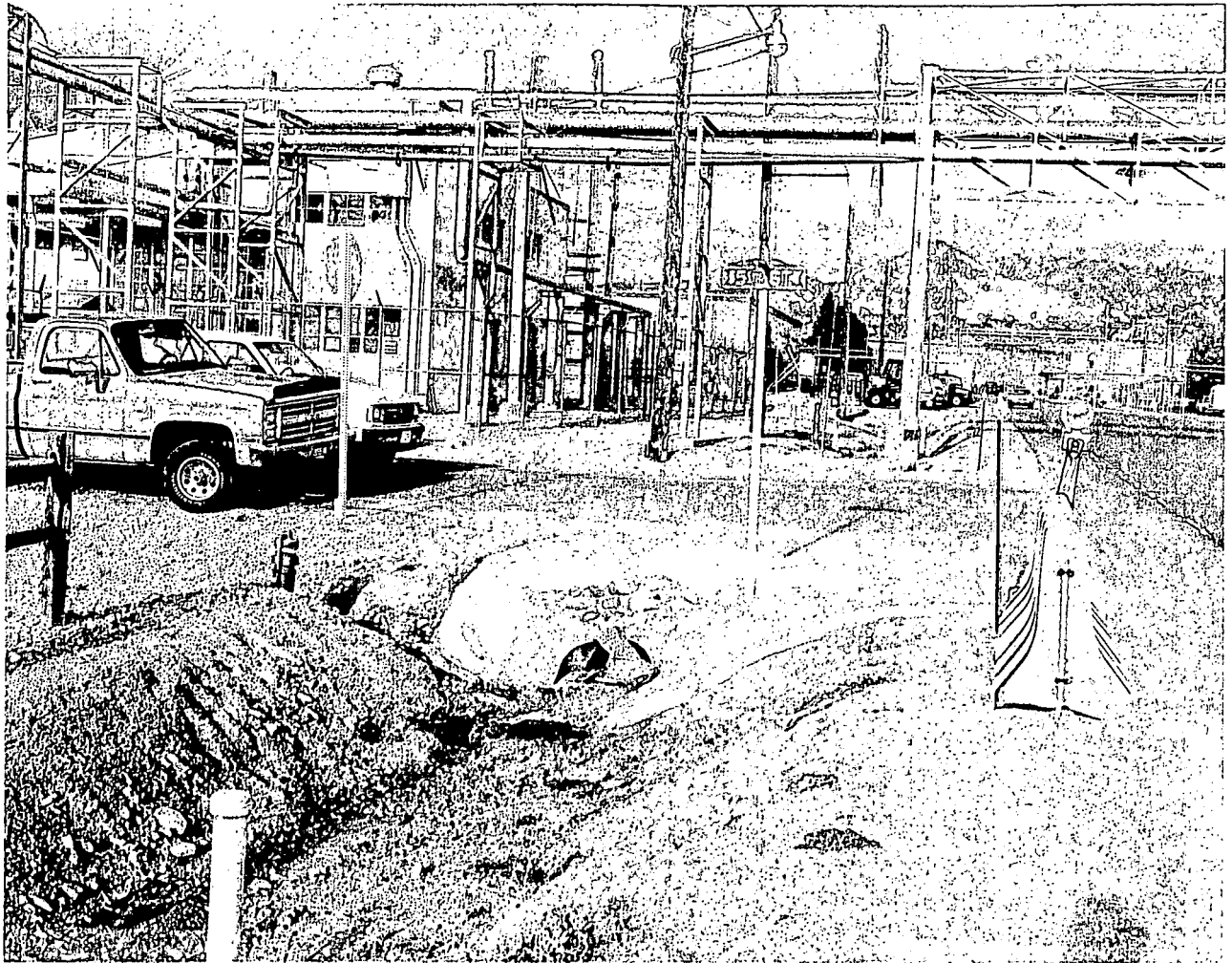
Neither of these incidents is likely to have produced any contaminants that are hazardous to human health and the environment, which are detectable this long after the releases.

#### 2.1.1.14 Hydrogen Peroxide Spill (IHSS 191)

This IHSS resulted from an item reported in "Environmental Analysis Weekly Highlights, Week ending April 24, 1981". During the week, warehouse personnel were transporting three 55-gallon drums of Hydrogen Peroxide ( $H_2O_2$ , 35% solution) when two of the drums fell from the pallet.

One of the drums burst open and the contents drained into a culvert at the corner of Fifth Street and Central Avenue (Figures 2-13 and 2-20). In accordance with proper spill management procedures, a containment hole was constructed east of 5th Street by labor personnel and the area was hosed down by the Fire Department allowing the diluted  $H_2O_2$  to drain into the hole. The hole was refilled on April 23, 1981.

This spill was probably the spill that was inaccurately reported in RCRA 3004(u) which became IHSS 169. A complete discussion of that IHSS appears in Section 2.1.1.10. As reported in that section,  $H_2O_2$  reacts in the presence of dirt to form  $O_2$  and  $H_2O$  which are not hazardous. Any traces of this event likewise would have disappeared long ago. We feel that the documentation presented is sufficient to support a no further action justification by the agencies in the record of decision.



IHSSs 191 AND PART OF 190  
LOOKING WEST

OU132-20.DWG

OPERABLE UNIT NO. 13  
PHASE I RFI/RI WORK PLAN  
FIGURE 2-20  
U.S. DEPARTMENT OF ENERGY  
Rocky Flats Plant, Golden, Colorado

### 2.1.2 Topography

Topographic relief on the east-northeast sloping Rocky Flats alluvial surface within OU13 is approximately 47 feet. Elevation extremes of 6,037 feet above Mean Sea Level (MSL) occur adjacent to Building 202 and 5,990 feet above MSL to the west of Building 419 located in the southwestern and central northwestern areas of OU13. The topography in the vicinity of the RFP is shown on Figure 1-4.

### 2.1.3 Geology

At the RFP, core drilling and geologic logging have been essential to characterization of the subsurface geologic materials due to lack of onsite or adjacent outcrop exposures. Through numerous investigations, the variety and thickness of underlying materials have been disclosed to consist of surficial clastic sediments and deeper, underlying, indurated sedimentary units at the RFP. Data for selected wells and boreholes within and immediately adjacent to OU13 are given in Table 2.1. Geologic data presented for these 23 wells includes location, type and thickness of surficial materials, elevation to the top of Arapahoe Formation bedrock, and type of bedrock intersected. Well completion, hydrologic, and geologic information for these boreholes are contained in Appendices A and B. Figure 2-21 depicts the surficial geology in the Controlled Area (CA) of the RFP. This map indicates that nearly all natural materials (soils atop Rocky Flats Alluvium) have been disturbed, filled, or covered by pavement and structures.

#### 2.1.3.1 Rocky Flats Alluvium

Based upon mapping by Hurr (Hurr, 1976) and EG&G (1992a), nearly all of the CA at the RFP is underlain by Rocky Flats Alluvium. These sediments are covered by thin soils, colluvium, artificial fill materials, and the RFP structures. The Rocky Flats Alluvium generally ranges from slightly more than 50 feet to less than 10 feet in thickness at the CA as determined by drill core

Table 2.1  
List of Selected Wells and Boreholes at Operable Unit 13 Area  
Rocky Flats Plant

		State	State	Surface	T.O.C.		TD	Type	Thick	El. Top	Upper	Low	High	
	Well No.	North	East	Elevation	Elevation	TD	Elevation	Alluvium	Qrf	Bedrock	Bedrock	Water Level	Water Level	Screened
												Below Surface	Below Surface	Interval
1	P416989	748,780	2,081,034	6,045.20	NA	220.0	5,825.20	Qrf	30.0	6,015.20	Claystone	38.72	NR	151.2 - 155.6
2	P115189	749,641	2,081,236	6,034.00	No survey	42.3	5,991.70	Qrf	38.3	5,995.70	Claystone	NR	NR	31.3 - 35.7
3	P416289	748,578	2,081,555	6,038.60	6,040.22	43.0	5,995.60	0 - 2.7 Fill/Qrf	20.3	6,015.60	Silty Claystone	14.97	9.76	19.1 - 23.5
4	P114989	749,959	2,081,661	6,029.80	6,031.84	43.5	5,986.30	0 - 9.5 Fill/Qrf	28.0	5,992.30	Claystone	12.25	12.23	33.6 - 38
5	P119389	750,280	2,081,921	6,011.70	6,013.18	26.0	5,985.70	Qrf	16.4	5,995.30	Silty Claystone	4.98	4.35	12.5 - 16.9
6	P114889	749,926	2,082,127	6,016.60	6,018.26	18.0	5,998.60	0 - 3 Fill/Qrf	10.8	6,002.80	Sandy Claystone	5.87	4.18	9.9 - 14.2
7	P115489	749,507	2,082,135	6,023.40	6,025.10	31.0	5,992.40	0 - 6 Fill/Qrf	20.0	5,997.40	Claystone	11.76	7.2	22.1 - 26.4
8	4486	749,254	2,082,234	6,019.93	6,021.96	33.0	5,986.93	Qrf	25.0	5,994.93	Silty Claystone	12.40	7.9	3.2 - 26.2
9	P416789	748,206	2,082,382	6,027.80	6,029.27	30.0	5,997.80	0 - 2.5 Fill /Qrf	23.9	6,001.65	Claystone	26.17	21.88	22.5 - 26.9
10	P419689	748,522	2,082,513	6,022.40	6,023.42	33.0	5,989.40	0 - .4 Fill/Qrf	21.6	6,000.40	Sandstone	19.74	16.16	19.1 - 22
11	P114789	749,940	2,082,610	6,010.70	6,012.40	31.0	5,979.70	0 - 1.5 Fill/Qrf	24.5	5,984.70	Claystone	9.81	6.17	21.8 - 26.2
12	P418289	748,952	2,082,653	6,016.90	6,018.20	33.0	5,983.90	0 - 2 Fill/Qrf	21.0	5,993.90	Claystone	9.53	6.08	9.5 - 23.5
13	P115589	749,551	2,082,658	6,014.10	6,015.77	33.6	5,980.50	0 - 29 Fill	0.0	5,985.10	Claystone	8.33	2.88	25. - 29.5
14	P414189	749,059	2,082,986	6,010.60	6,012.18	28.0	5,982.60	0 - 4 Fill/Qrf	14.0	5,992.60	Claystone	8.84	4.09	14.1 - 18.5
15	P115689	749,532	2,083,019	6,006.90	6,008.71	23.5	5,983.40	0 - 3.5 Fill/Qrf	16	5,987.20	Claystone	12.40	5.80	16.2 - 20.2
16	P214689	749,943	2,083,044	6,004.00	6,005.76	26.0	5,978.00	0 - .7 Fill/Qrf	21	5,982.00	Silty Claystone	12.07	6.73	17.8 - 22.2
17	P313489	748,913	2,083,062	6,011.70	6,013.58	24.0	5,987.70	0 - .7 Fill/Qrf	20	5,991.10	Claystone	13.91	8.29	16.7 - 21.1
18	P215789	749,470	2,083,430	6,002.00	6,003.66	22.0	5,980.00	0 - 2.8 Fill/Qrf	15.2	5,984.00	Claystone	14.50	12.17	14.5 - 18.5
19	P214089	749,461	2,083,653	5,996.70	5,998.49	19.0	5,977.70	0 - 3.3 Fill/Qrf	6.0	5,987.40	Claystone	Dry	7.88	5.4 - 9.8
20	6186	749,198	2,083,717	5,999.47	6,000.76	18.5	5,980.81	Qrf	11.5	5,987.81	Silty Claystone	9.57	8.69	5.0 - 12.0
21	P213689	749,460	2,083,736	5,994.30	5,996.04	23.0	5,971.30	0 - 6 Fill/Qrf	7.0	5,981.30	Claystone	8.29	6.75	9.1 - 13.5
22	P218089	749,941	2,084,020	5,985.80	5,987.55	16.0	5,969.80	Qrf	6.0	5,979.80	Claystone	Dry	4.54	3.0 - 7.4
23	P317989	748,891	2,084,272	5,990.90	5,992.84	16.0	5,974.90	Qrf	6.4	5,984.50	Claystone	7.87	2.39	3.0 - 7.5

- Notes:
1. This tabulation lists 23 wells and boreholes beginning in the area west of OU13 and proceeding eastward.
  2. This tabulation does not include wells/boreholes in the eastern part of OU13.
  3. List current as of 31 July 1991.
  4. High water levels 07 June to 20 June 1991; low water levels 03 January to 04 January 1991.
  5. Source: EG&G Rocky Flats, 1991. Geological Characterization Report, Appendix A, 31 July 1991.

NR = Water level not reported or not observed.

T.O.C. = Top of casing

TD = Total Depth

Qrf = Rocky Flats Alluvium

analysis. Table 2.1 lists the thickness of Rocky Flats Alluvium as intersected in core within and immediately adjacent to OU13. The thickness extremes range from 0 to 38.3 feet with thicker intervals on the western side of OU13. Earthmoving for facilities construction at the RFP has locally removed all alluvial materials to bedrock (see Well P115589, Table 2.1) and restored to design surface elevation with artificial fill.

#### 2.1.3.2 Colluvium

These geologic materials are sediments derived directly from the Rocky Flats Alluvium and generally deposited along the slopes surrounding the dissected, alluvium-covered pediment. These materials are limited at OU13 but exist on the steep slopes in the extreme north central area as shown in Figure 2-20. Colluvium has not been identified in the core intercept data furnished in Table 2.1.

#### 2.1.3.3 Soils

The soils at OU13 consist of the Flatiron Series, located on Rocky Flats Alluvium; Nederland Series, commonly located on the upper slopes flanking Rocky Flats Alluvium; and Denver-Kutch-Midway Series, located on slopes flanking the previous soils. The area of OU13 was nearly completely covered by the Flatiron Series soils prior to construction of the RFP. No soils are distinguished in the core intercepts given in Table 2.1.

#### 2.1.3.4 Artificial Fill

Geologic materials native to the site (Rocky Flats Alluvium) and imported materials have been used as fill at the RFP for road grade and berm construction, recontouring peripheral to structures, and surface impoundments. Artificial fill thicknesses have been described in drill intercepts and are tabulated in Table 2.1. Crushed rock has been used for landscaping and



levelling at the site. Pavement and gravel, in addition to buildings and disturbed ground, cover OU13.

#### 2.1.3.5 Buried Bedrock Surface

Based upon drill hole data and interpretation, the thickness of surficial materials is contoured in Figure 2-22, which also shows topographic contours. The isopach contours show the surficial materials are thickest in the western section of the CA and thinnest in the northern and southeastern areas. Within the area enclosed by OU13, the surficial materials generally thin eastward; thicknesses range from 30 to less than 10 feet.

These surficial sediments had been deposited on an older erosional surface. The depositional event occurred between early to middle Pleistocene time (Nasser et. al., 1973). The oldest erosional surface below the Rocky Flats Alluvium is that developed upon the Arapahoe Formation by pedimentation processes. This surface or pediment represents a pause in the sedimentation process located in the High Plains area. The surface is preserved as the top-of-bedrock now recognized by drill core evaluation.

This paleotopographic surface is preserved from subsequent and present-day erosion in the RFP vicinity only where covered by Rocky Flats Alluvium. Some parts of the Rocky Flats Alluvium within the CA have been removed by headward (westward) erosion of North and South Walnut Creeks and Woman Creek. As a consequence, the preserved pre-Rocky Flats Alluvium pediment surface now can be found beneath approximately 90 percent of the CA. This area is shown on Figure 2-23. This map depicts present-day surface topography and shows contours of the subsurface paleotopography at the time of deposition of the Rocky Flats Alluvium.

Three paleoridges and two prominent paleodrainages in the vicinity of OU13 are interpreted on Figure 2-23. This paleodrainage pattern could influence groundwater flow in the lower part of the Rocky Flats Alluvium. This is a consequence of the configuration and relatively lower permeability of the claystone bedrock found in the Arapahoe Formation in contrast to the relatively higher permeability of the Rocky Flats Alluvium. The direction of groundwater flow may be influenced by the permeability contrast, with the water tending to flow through the more permeable alluvium. In the extreme case, groundwater flow may be channelized within a paleochannel.

### Arapahoe Formation

The geological description of OU13 was derived from the Geological Characterization Report (EG&G, 1991c), and much of the site-specific information was obtained from the 1986, 1987, and 1989 borehole drilling and well installation programs. The borehole logs and completion data are presented in EG&G (1991c), and ASI (1991c, 1991d). Additional tabulated geologic data is presented in Appendix B.

There were ten wells completed in OU13 during previous drilling and well installation programs. Of these ten wells, none penetrate more than 10 feet into the bedrock. Directly below the Quaternary/Cretaceous unconformity, six wells (P114789, P115489, P115589, P115689, P313489, and P414189) encountered claystone; three wells (44-86, 61-86, and P214689) encountered silty claystone; and one (P114889) encountered sandy claystone. In general, these claystones are moderately to highly weathered with iron staining. They also usually contain a small percentage of a coarser grained constituents, ranging from silt to coarse grained sand.

In the immediate surrounding area, there are two deeper wells: P416289 is 43 feet deep, and P416989 is 220 feet deep. Both of these wells are southwest of OU13. The upper bedrock

lithologies of these wells show fining upward sequences. Table 2.2 reveals that the sequences range from 2.3 feet thick (38.0 to 40.3 in Well P416289) to 11 feet thick (27.0 to 33.0 in Well P416289). The deeper lithologies of Well P416989 consist predominately of claystone with some silty claystone and siltstones. There is also an interval of interbedded sandstone and silty claystone at 96.3 to 98.6 feet in depth.

Another significant well is P313589 located southeast of OU13. The suballuvial lithology is two feet of silty clayey sandstone. This interval is very fine to fine grained, has interbedded claystone units, and is highly weathered. Underlying is 4.8 feet of silty sandstone. The sandstone is very fine to fine grained, interbedded with sandy claystone, and has iron staining present.

The Arapahoe Formation contains several sandstone intervals. The upper most sandstone unit is referred to in the Geological Characterization Report as the No. 1 Sandstone. The following geologic model is taken directly from that report. Figures 2-24 and 2-25 are isopach maps which present two interpretations for the No. 1 Sandstone in the OU13 area. These maps are highly interpretive since subsurface control is sparse. The first interpretation shows a continuous single channel system. Channel and point bar deposits are both recognized; however, channel fill deposits dominate. The second interpretation depicts a multiple channel system containing migrated channel and point bar deposits. Both interpretations imply lenticular geometries of individual sandstones and that the sandstones may not be in hydraulic connection. (EG&G, 1991c).

Both interpretations recognize that the No. 1 Sandstone consists of more than one fining upward sequence. The Geological Characterization Report states that a minimum of three fining upward sequences are recognized where penetration of the No. 1 Sandstone is complete. Information from drilling is presented in Table 2.2 for wells within and surrounding OU13. Note that the

**TABLE 2.2: Lithology in Selected Wells and Boreholes Within and Surrounding Operable Unit 13**

Well No.	Within OU13	Elevation Top of Bedrock	Amount of Bedrock Penetrated (Feet)	Presence of No. 1 Sandstone	Fining Upward Sequences	Lithology from Top Bedrock to TD	Depth of Top of Lithology (Feet)	Thickness of Lithology (Feet)	Comments
4486	YES	5,994.93	7.5		UNKNOWN	Silty Claystone	25.5	7.5+	Highly weathered, trace sand
6186	YES	5,987.81	7		UNKNOWN	Silty Claystone	11.5	7.0+	Trace sand, vfg to coarse
P313489	YES	5,991.10	5.4		UNKNOWN	Claystone	20.6	1.4	Trace silt
						No Sample	22.0	2.0	
						Claystone	24.0	2.0+	Trace silt, iron staining
P313589	NO		10	No. 1 SS		Silty Clayey Sandstone	12.0	2.0	Interbedded claystone, highly weathered, vfg to fg
						Silty Sandstone	14.0	4.8	Interbedded sandy claystone, iron staining
						Silty Claystone	18.8	3.2+	
P213689	NO	5,981.30	8			Claystone	13.0	2.0	Trace silt and vfg sand
						No Sample	15.0	2.0	
				No. 1 SS		Claystone	17.0	2.0	Mod weathered, some vfg sand
						Clayey Sandstone	19.0	1.0	Top of No. 1 Sandstone, vfg, well sorted
						Silty Sandstone	20.0	1.0+	Vfg to mg, well rounded, subangular
P314089	NO	5,987.40	9.7		UNKNOWN	Claystone	9.3	4.7	Trace to some silt
						No Sample	14.0	2.0	
						Claystone	16.0	3.0	
P414189	YES	5,992.60	10			Claystone	18.0	8.0	Trace silt
						Silty Claystone	26.0	2.0+	
P214689	YES	5,982.00	4		UNKNOWN	Silty Claystone	22.0	4.0+	Trace vfg sand, well sorted
P114789	YES	5,984.70	5		UNKNOWN	No Sample	26.0	1.0	
						Claystone	27.0	2.0	
						No Sample	29.0	1.0	
						Claystone	30	1.0+	
P114889	YES	6,002.80	4.2		UNKNOWN	Sandy Claystone	13.8	4.2+	Moderately weathered, fg sand
P114989	NO	5,992.30	6			Claystone	37.5	4.0	Moderately weathered, some silt
						Silty Claystone	41.5	2.0+	Trace sand
P115189	NO		4.0		UNKNOWN	Claystone	38.3	2.0	Mod weathered
						No Sample	40.3	0.7	
						Claystone	41.0	1.3+	Mod weathered
P115489	YES	5,997.40	5		UNKNOWN	Claystone	26.0	5.0+	
P115589	YES	5,985.10	4.6		UNKNOWN	Claystone	29.0	4.6+	Silty

**TABLE 2.2: Lithology in Selected Wells and Boreholes Within and Surrounding Operable Unit 13**

Well No.	Within OU13	Elevation Top of Bedrock	Amount of Bedrock Penetrated (Feet)	Presence of No. 1 Sandstone	Fining Upward Sequences	Lithology from Top Bedrock to TD	Depth of Top of Lithology (Feet)	Thickness of Lithology (Feet)	Comments
P115689	YES	5,987.20	3.8		UNKNOWN	Claystone	19.7	3.8+	Moderately Weathered
P215789	NO	5,984.00	4		UNKNOWN	Claystone	18.0	4.0+	Highly Weathered
P416289	NO	6,015.60	20.5	No. 1 SS		Silty Claystone	22.5	3.5	No. 1 Sandstone 1.5 below top of bedrock, interbedded clay
						Clayey Siltstone	26.0	1.0	
						Silty Claystone	27.0	4.0	Some carbonaceous, heavy hematite zones
						Clayey Siltstone	31.0	4.0	
						Clayey Sandstone	33.0	5.0	Vfg & Fg, angular to subangular, well sorted, hematite staining
						Silty Claystone	38.0	2.0	Some sand, some hematitic zones
						Clayey Sandstone	40.0	0.3	Vfg to cg sand, mod well sorted, subrounded to rounded
					UNKNOWN	Silty Claystone	40.3	2.7+	Sandy interval, disseminated and nodular hematite
P416789	NO		3.6		UNKNOWN	Claystone	26.4	3.6+	Trace sand, some silt increasing with depth, some iron staining
P416989	NO	6,015.20	190	No. 1 SS		Claystone	30.0	4.9	Very highly weathered
						Clayey Sandstone	34.9	0.3	Very highly weathered
						Silty Claystone	35.9	3.0	Very highly weathered, some sand
						Silty Sandstone	38.2	1.0	Very highly weathered
						Silty Claystone	39.2	6.0	Highly weathered, interbedded ironstone, some mg to cg sand
						Sandy Claystone	45.2	3.2	Sand content increasing with depth, intervals of sandstone
						Clayey Sandstone	48.2	0.8	Vfg, subangular to subrounded, mod sorting
						Sandy Claystone	49.2	1.8	Vfg, subangular to subrounded, well sorting
						Clayey Sandstone	51.0	2.6	Vfg, subangular, mod sorting, v. friable
						No Sample	53.6	1.3	
						Silty Claystone	54.9	0.5	Some vfg sand
						No Sample	55.4	4.1	
						Silty Claystone	59.5	2.0	Some vfg sand
						Sandy Claystone	61.5	5.2	Some silt, sand is vfg, mod friable
						Claystone	66.7	13.3	Some silt, some carbonaceous material
(REMAINING LOWER LITHOLOGIES NOT INCLUDED)									
P417889	NO		0.5		UNKNOWN	Claystone	21.5	0.5+	Trace carbonaceous material
P317989	NO	5,984.50	9.6		UNKNOWN	Claystone	6.4	9.6	Mod weathered, tr silt, cg to vfg sand, well sorted and rounded
P218089	NO	5,979.80	10			Claystone	6.0	4.0	Highly Weathered, trace vfg sand, trace silt

**TABLE 2.2: Lithology in Selected Wells and Boreholes Within and Surrounding Operable Unit 13**

Well No.	Within OU13	Elevation Top of Bedrock	Amount of Bedrock Penetrated (Feet)	Presence of No. 1 Sandstone	Fining Upward Sequences	Lithology from Top Bedrock to TD	Depth of Top of Lithology (Feet)	Thickness of Lithology (Feet)	Comments
				No. 1 SS		Silty Claystone	10.0	2.4	Some vfg sand
					UNKNOWN	Clayey Silty Sandstone	12.4	0.6	Vfg, well sorted, mod rounded
					UNKNOWN	Silty Claystone	13.0	1.0	
					UNKNOWN	Claystone	14.0	2.0+	
P418289	NO	5,993.90	10		UNKNOWN	Claystone	23.0	10+	Moderately Weathered, trace silt
P119289	NO		9.8			Claystone	4.2	3.8	Iron staining, trace silt
						Silty Claystone	8.0	6.0+	Iron staining, increasing silt content with depth
P119389	NO		9.6		UNKNOWN	Silty Claystone	16.4	1.6	Iron staining, trace carbonaceous material
						Claystone	18.0	2.0	Claystone and Silty Claystone, iron staining, trace carbonaceous
						Silty Claystone	20.0	2.0	Iron staining, trace carbonaceous
						Claystone	22.0	2.0	
						Silty Claystone	24.0	2.0+	Iron staining, trace carbonaceous
P419689	NO		11.0	No. 1 SS	UNKNOWN	Silty Sandstone	22.0	1.0	Mg to cg, mod sorted, rounded to sub-rounded
						Silty Claystone	23.0	6.4	Weathered, iron staining, decreasing silt content with depth
						Claystone	29.4	3.6+	

- Notes:
1. Presence of No. 1 Sandstone is based on the Geological Characterization Report, Appendix A (EG&G, 1991)
  2. Lithology is based well logs found in the Geological Characterization Report, (EG&G, 1991)

wells actually in OU13 do not definitively penetrate the No. 1 Sandstone, and that the interpretations given are extrapolated beneath OU13 from other distant well locations.

Interpretation 1 (Figure 2-24) shows north-south trending No. 1 Sandstone channel crossing beneath OU13. The two wells which intersect the channel in OU13, P114789 and P115589, are only completed into the bedrock 5.0 and 4.6 feet, respectively. The sub-alluvial lithology in these wells was logged as claystone, which may or may not be interpreted as the upper portion of a fining upward sequence. Cross-sections A-A', B-B', C-C', D-D', E-E', and F-F' (Figures 2-26 to 2-30) show an idealized conceptual model for this interpretive channel. These cross-sections were directly extrapolated from the isopach maps presented in the Geological Characterization Report.

Interpretation 2 (Figure 2-25) shows the distribution of the No. 1 Sandstone in the southern portion of the unit. It indicates that the No. 1 Sandstone may have a lateral extent of approximately 450 feet within OU13. Three wells within OU13 also exist within the boundary of the channel system. Well 44-86 penetrates 8 feet of bedrock into a uniform silty claystone. Wells P218289 and P313489 penetrate 10 and 5.4 feet of bedrock, respectively, into claystone with a trace of silt. This claystone may or may not be interpreted as the upper portion of a fining upward sequence. Cross-sections A-A', B-B', C-C', and D-D' show an idealized conceptual model for this interpretive channel. These cross-sections were directly extrapolated from the isopach maps presented in the Geological Characterization Report.

The top of bedrock surface shows the remnants of the Pre-Wisconsin pediment as well as the effects of recent stream incisement (EG&G, 1991c). The paleotopography in the vicinity of OU13 is shown in Figure 2-22. Immediately south of the OU13 area, the top of the bedrock forms a paleotopographic high trending east-west. Other minor paleoridges extend north-northeast beyond the northwest corner and northeast beneath the eastern portion of OU13. A

paleotopographic low between the minor paleoridges trends east-northeast in the southwest portion, then trends northeast in the northwest portion. This low has a gradient ranging between 10-20 feet per 1,000 feet in the southwest, steepening to 40-50 feet per 1,000 feet in the northeast.

Additional wells are needed that penetrate the bedrock to a depth deep enough to evaluate the presence of the No. 1 Sandstone. First priority should be given to those areas in OU13 where the No. 1 Sandstone has been interpreted to be located, namely the east portion (Interpretation 1) and the southern half (Interpretation 2).

#### 2.1.4 Hydrogeology

The characterization of the groundwater flow regime in OU13 is limited to water level measurements from nine alluvial piezometers and one alluvial monitoring well (Figure 2-31). There are no bedrock monitoring wells or piezometers within OU13. The groundwater system is dynamic with wide fluctuations in water level over a short period of time as a result of rapid responses to short-term weather conditions and over longer periods of time reflecting seasonal stresses.

##### 2.1.4.1 Recharge and Discharge

OU13 is within a regional recharge area (EG&G, 1991c); however local areas of recharge and discharge exist. Recharge resulting from incident precipitation occurs over most of the unpaved or uncovered areas of OU13, approximately less than 20 percent of the total area. Two surface drainages are present. An unnamed tributary of North Walnut Creek acts as a gaining stream (discharge area) with year-round baseflow contribution as evidenced by the presence of marshes



along most of its extent within the OU13 area. The manmade drainage ditch on the south side of Central Avenue (within the drainage basin of South Walnut Creek) is probably always a losing stream and therefore a source of recharge to the groundwater system during periods of precipitation. Groundwater also enters the RFP area by lateral flow from upgradient areas.

#### 2.1.4.2 Piezometers and Monitoring Wells

With the exception of two wells, 44-86 and 61-86, all wells in OU13 were installed in 1989 as non-regulatory groundwater characterization piezometers during the 1989 geologic characterization project (EG&G, 1991d). All wells within the OU13 boundary are alluvial piezometers which extend a few feet into the Arapahoe claystone, silty claystone, or sandy claystone.

Water levels have been measured on a monthly basis since installation of the wells in 1989 and 1990 (Table 2.3). No groundwater sampling has been done on the 1989 wells within the OU13 area.

Well 44-86 is a non-regulatory groundwater characterization well installed in 1986. It is sampled quarterly for groundwater chemistry and measured monthly for water level elevations (Table 2.3). Hereinafter, piezometers and monitoring wells collectively will be called wells.

#### 2.1.4.3 Hydrostratigraphic Units

The uppermost hydrostratigraphic unit consists solely of surficial materials, Rocky Flats Alluvium, artificial fill, and a limited amount of valley fill alluvium along the unnamed tributary of North Walnut Creek. Although the uppermost Arapahoe sandstone exists in hydraulic connection with the surficial materials in other areas at the RFP, notably to the southeast of OU13 in Well P313589, limited borehole control indicates that the uppermost Arapahoe

Table 2.3

Selected Piezometer and Groundwater Monitor Wells  
Water Level Elevations through March 5, 1992

Well No.	Elevation	Date	Well No.	Elevation	Date	Well No.	Elevation	Date	Well No.	Elevation	Date
4486	6016.16	10-Nov-86	4486	6006.06	06-Dec-89	6186	5991.66	28-Oct-87	6186	5990.92	03-Oct-90
4486	6015.34	13-Nov-86	4486	6006.96	16-Jan-90	6186	5991.96	02-Nov-87	6186	5990.48	02-Nov-90
4486	6013.46	01-Jan-87	4486	6014.33	23-Mar-90	6186	5991.66	21-Dec-87	6186	5990.39	13-Dec-90
4486	6012.88	08-May-87	4486	6013.95	12-Apr-90	6186	5991.46	11-Jan-88	6186	5989.90	04-Jan-91
4486	6015.07	02-Jun-87	4486	6012.21	14-Jun-90	6186	5989.94	04-Feb-88	6186	5990.78	12-Jun-91
4486	6015.81	08-Jul-87	4486	6013.25	10-Jul-90	6186	5990.86	29-Feb-88	6186	5990.84	03-Jul-91
4486	6013.26	04-Aug-87	4486	6013.02	15-Aug-90	6186	5990.86	21-Mar-88	6186	5991.23	05-Aug-91
4486	6012.36	21-Aug-87	4486	6012.78	27-Aug-90	6186	5991.36	18-Apr-88	6186	5991.43	07-Aug-91
4486	6012.86	01-Sep-87	4486	6012.29	14-Sep-90	6186	5990.76	16-May-88	6186	5990.56	05-Sep-91
4486	6011.26	29-Sep-87	4486	6012.61	04-Oct-90	6186	5990.66	15-Jun-88	6186	5990.86	02-Oct-91
4486	6010.36	02-Nov-87	4486	6012.60	05-Nov-90	6186	5992.26	15-Jul-88	6186	5990.46	17-Oct-91
4486	6010.36	11-Nov-87	4486	6011.83	07-Dec-90	6186	5990.56	18-Aug-88	6186	5991.27	04-Nov-91
4486	6009.96	21-Dec-87	4486	6011.71	11-Dec-90	6186	5990.76	15-Sep-88	6186	5991.44	03-Dec-91
4486	6009.96	11-Jan-88	4486	6005.50	03-Jan-91	6186	5990.26	22-Oct-88	6186	5990.47	07-Jan-92
4486	6015.26	29-Feb-88	4486	6012.32	18-Mar-91	6186	5990.76	15-Nov-88	6186	5991.01	21-Jan-92
4486	6015.46	21-Mar-88	4486	6012.66	02-Apr-91	6186	5990.36	15-Dec-88	6186	5991.01	21-Jan-92
4486	6015.76	18-Apr-88	4486	6014.24	06-May-91	6186	5990.36	15-Jan-89	6186	5990.49	06-Feb-92
4486	6015.06	16-May-88	4486	6014.06	07-Jun-91	6186	5993.86	17-Feb-89	6186	5990.27	02-Mar-92
4486	6014.66	15-Jun-88	4486	6013.26	20-Jun-91	6186	5990.86	27-Mar-89	P313489	5998.12	16-Jan-90
4486	6014.26	15-Jul-88	4486	6012.28	05-Jul-91	6186	5989.86	27-Apr-89	P313489	6002.73	25-Apr-90
4486	6013.96	18-Aug-88	4486	6013.83	08-Aug-91	6186	5992.26	19-May-89	P313489	5999.82	09-Aug-90
4486	6014.76	15-Sep-88	4486	6013.55	14-Aug-91	6186	5990.76	29-Jun-89	P313489	5998.96	11-Sep-90
4486	6010.16	22-Oct-88	4486	6012.06	03-Sep-91	6186	5990.58	21-Jul-89	P313489	5999.15	05-Nov-90
4486	6012.86	15-Nov-88	4486	6011.06	04-Oct-91	6186	5991.33	25-Aug-89	P313489	5998.68	04-Dec-90
4486	6007.46	15-Dec-88	4486	6011.42	04-Nov-91	6186	5991.71	14-Sep-89	P313489	5997.79	02-Apr-91
4486	6013.56	15-Jan-89	4486	6012.25	08-Nov-91	6186	5990.46	06-Dec-89	P313489	6000.70	02-May-91
4486	6015.16	17-Feb-89	4486	6013.49	07-Dec-91	6186	5990.41	18-Jan-90	P313489	6003.41	07-Jun-91
4486	6015.16	27-Mar-89	4486	6011.32	09-Jan-92	6186	5993.01	23-Mar-90	P313489	DRY	05-Jul-91
4486	6015.16	27-Apr-89	4486	6011.70	03-Feb-92	6186	5991.62	26-Apr-90	P313489	6001.09	08-Aug-91
4486	6015.76	19-May-89	4486	6011.69	05-Feb-92	6186	5990.94	18-May-90	P313489	5999.51	03-Sep-91
4486	6015.56	29-Jun-89	6186	5590.96	08-Jul-87	6186	5990.98	11-Jul-90	P313489	5998.45	07-Oct-91
4486	6014.16	14-Jul-89	6186	5990.56	06-Aug-87	6186	5990.94	03-Aug-90	P313489	5998.46	05-Nov-91
4486	6014.09	25-Aug-89	6186	5991.46	25-Aug-87	6186	5990.87	15-Aug-90	P313489	6001.35	02-Dec-91
4486	6016.11	13-Sep-89	6186	5990.86	01-Sep-87	6186	5990.90	07-Sep-90	P313489	5998.98	03-Feb-92

Table 2.3

Selected Piezometer and Groundwater Monitor Wells  
Water Level Elevations through March 5, 1992

<u>Well No.</u>	<u>Elevation</u>	<u>Date</u>	<u>Well No.</u>	<u>Elevation</u>	<u>Date</u>	<u>Well No.</u>	<u>Elevation</u>	<u>Date</u>	<u>Well No.</u>	<u>Elevation</u>	<u>Date</u>
P313489	5998.07	03-Mar-92	P414189	6004.00	02-May-91	P114789	6002.17	02-Apr-91	P114989	6017.23	15-Jan-90
P213689	5986.80	07-Oct-89	P414189	6005.51	07-Jun-91	P114789	6003.79	01-May-91	P114989	6017.19	25-Apr-90
P213689	5983.83	15-Jan-90	P414189	6004.62	05-Jul-91	P114789	6004.53	07-Jun-91	P114989	6017.94	12-Jul-90
P213689	8987.57	25-Apr-90	P414189	6003.95	08-Aug-91	P114789	6002.92	02-Jul-91	P114989	6017.57	07-Jun-91
P213689	5987.42	14-Aug-90	P414189	6003.81	03-Sep-91	P114789	6004.76	08-Aug-91	P114989	6018.09	02-Jul-91
P213689	5987.39	10-Sep-90	P414189	6001.96	07-Oct-91	P114789	6002.77	04-Sep-91	P114989	6017.84	08-Aug-91
P213689	5987.28	04-Oct-90	P414189	6001.58	05-Nov-91	P114789	6002.73	04-Oct-91	P114989	6019.32	03-Sep-91
P213689	5986.98	05-Nov-90	P414189	6004.83	02-Dec-91	P114789	6003.27	04-Nov-91	P114989	6019.13	04-Oct-91
P213689	5986.76	04-Dec-90	P414189	6004.14	02-Jan-92	P114789	6004.54	02-Dec-91	P114989	6018.87	05-Nov-91
P213689	5986.01	03-Jan-91	P414189	6004.11	03-Feb-92	P114789	6002.96	02-Jan-92	P114989	6019.02	02-Dec-91
P213689	5986.45	02-Apr-91	P414189	6003.36	03-Mar-92	P114789	6003.10	03-Feb-92	P114989	6018.21	02-Jan-92
P213689	5986.88	01-May-91	P114489	6022.68	15-Sep-89	P114789	6002.39	02-Mar-92	P114989	6017.27	03-Feb-92
P213689	5987.55	07-Jun-91	P114489	6019.63	15-Jan-90	P114889	6008.22	19-Jan-90	P114989	6016.71	02-Mar-92
P213689	5987.46	02-Jul-91	P114489	6018.79	01-Apr-91	P114889	6010.93	25-Apr-90	P115089	6022.76	15-Jan-90
P213689	5987.52	08-Aug-91	P114489	6019.44	01-May-91	P114889	6012.48	11-Jul-90	P115089	6026.31	12-Jul-90
P214089	5988.24	12-Jul-90	P114489	6024.16	11-Jun-91	P114889	6012.66	09-Aug-90	P115089	6026.03	10-Aug-90
P214089	5987.56	14-Aug-90	P114489	6023.18	08-Jul-91	P114889	6012.64	10-Sep-90	P115089	6025.36	10-Sep-90
P214089	5987.13	10-Sep-90	P114489	6022.48	08-Aug-91	P114889	6012.55	03-Oct-90	P115089	6025.05	04-Oct-90
P214089	5986.69	04-Oct-90	P114489	6022.04	04-Sep-91	P114889	6011.91	05-Nov-90	P115089	6024.43	05-Nov-90
P214089	5986.23	05-Nov-90	P114489	6020.59	07-Oct-91	P114889	6011.28	04-Dec-90	P115089	6024.14	07-Dec-90
P214089	5985.73	04-Dec-90	P114489	6021.99	06-Nov-91	P114889	6010.73	03-Jan-91	P115089	6022.77	03-Jan-91
P214089	5998.49	03-Jan-91	P114489	6020.85	02-Dec-91	P114889	6010.91	02-Apr-91	P115089	6021.96	02-Apr-91
P214089	5986.75	02-Apr-91	P114489	6020.36	02-Jan-92	P114889	6011.43	01-May-91	P115089	6022.68	01-May-91
P214089	5986.93	01-May-91	P114489	6020.02	03-Feb-92	P114889	6012.42	11-Jun-91	P115089	6026.87	07-Jun-91
P214089	5988.82	07-Jun-91	P114489	6019.76	02-Mar-92	P114889	6012.82	02-Jul-91	P115089	6026.8	02-Jul-91
P214089	5988.96	02-Jul-91	P114789	6001.74	15-Jan-90	P114889	6013.08	08-Aug-91	P115089	6026.03	08-Aug-91
P214089	5989.19	08-Aug-91	P114789	6004.27	25-Apr-90	P114889	6013.04	04-Sep-91	P115089	6025.43	03-Sep-91
P214089	5988.96	05-Sep-91	P114789	6003.40	12-Jul-90	P114889	6012.69	04-Oct-91	P115089	6023.96	04-Oct-91
P214089	5988.7	07-Oct-91	P114789	6002.80	09-Aug-90	P114889	6012.13	04-Nov-91	P115089	6023.1	05-Nov-91
P214089	5988.62	04-Nov-91	P114789	6002.81	10-Sep-90	P114889	6011.70	02-Dec-91	P115089	6024.28	02-Dec-91
P214089	5990.15	02-Dec-91	P114789	6002.53	03-Oct-90	P114889	6011.33	02-Jan-92	P115089	6023.76	02-Jan-92
P214089	5989.49	02-Jan-92	P114789	6002.88	05-Nov-90	P114889	6011.09	03-Feb-92	P115089	6023.34	03-Feb-92
P214089	5989.15	03-Feb-92	P114789	6002.10	04-Dec-90	P114889	6011.22	02-Mar-92	P115089	6023.06	02-Mar-92
P214089	5988.81	03-Mar-92	P114789	6000.89	03-Jan-91	P114989	6019.04	15-Sep-89	P115489	6013.13	15-Jan-90

Table 2.3

Selected Piezometer and Groundwater Monitor Wells  
Water Level Elevations through March 5, 1992

<u>Well No.</u>	<u>Elevation</u>	<u>Date</u>	<u>Well No.</u>	<u>Elevation</u>	<u>Date</u>	<u>Well No.</u>	<u>Elevation</u>	<u>Date</u>	<u>Well No.</u>	<u>Elevation</u>	<u>Date</u>
P115489	6015.63	12-Jul-90	P115689	5995.89	04-Oct-91	P415889	6039.2	05-Jul-91	P416089	6045.48	15-Aug-90
P115489	6015.4	09-Aug-90	P115689	5996.36	04-Nov-91	P415889	6038.25	09-Aug-91	P416089	6044.58	10-Sep-90
P115489	6014.87	11-Sep-90	P115689	5999.29	04-Dec-91	P415889	6038.11	03-Sep-91	P416089	6043.96	03-Oct-90
P115489	6014.23	04-Oct-90	P115689	5997.14	09-Jan-92	P415889	6035.62	04-Oct-91	P416089	6043.79	05-Nov-90
P115489	6013.88	05-Nov-90	P115689	5997.53	03-Feb-92	P415889	6034.46	05-Nov-91	P416089	6043.84	04-Dec-90
P115489	6013.56	05-Dec-90	P115689	5996.35	02-Mar-92	P415889	6038.09	04-Dec-91	P416089	6038.7	04-Jan-91
P115489	6011.64	03-Jan-91	P215789	5988.41	10-Sep-90	P415889	6036.8	02-Jan-92	P416089	6039.51	02-Apr-91
P115489	6012.59	02-Apr-91	P215789	5988.28	03-Oct-90	P415889	6036.52	03-Feb-92	P416089	6045.94	01-May-91
P115489	6014.64	02-May-91	P215789	5988.32	05-Nov-90	P415889	6035.17	02-Mar-92	P416089	6049.6	11-Jun-91
P115489	6016.2	11-Jun-91	P215789	5988.04	05-Dec-90	P415989	6036.21	16-Jan-90	P416089	6046.38	05-Jul-91
P115489	6014.36	08-Jul-91	P215789	5987.50	03-Jan-91	P415989	6040.46	12-Jul-90	P416089	6048.08	08-Aug-91
P115489	6015.53	08-Aug-91	P215789	5987.50	02-Apr-91	P415989	6040.25	10-Aug-90	P416089	6045.11	03-Sep-91
P115489	6014.89	04-Sep-91	P215789	5988.60	01-May-91	P415989	6038.95	10-Sep-90	P416089	6042.26	04-Oct-91
P115489	6013.54	04-Oct-91	P215789	5989.83	07-Jun-91	P415989	6038.61	03-Oct-90	P416089	6041.6	05-Nov-91
P115489	6013.52	05-Nov-91	P215789	5988.33	02-Jul-91	P415989	6037.75	05-Nov-90	P416089	6047.03	04-Dec-91
P115489	6015.03	02-Dec-91	P215789	5989.38	08-Aug-91	P415989	6038	04-Dec-90	P416089	6045.28	02-Jan-92
P115489	6013.99	03-Jan-92	P215789	5988.14	05-Sep-91	P415989	6034.85	04-Jan-91	P416089	6045.3	03-Feb-92
P115489	6014.13	03-Feb-92	P215789	5987.84	07-Oct-91	P415989	6034.83	02-Apr-91	P416089	6041.98	02-Mar-92
P115489	6013.23	02-Mar-92	P215789	5987.96	04-Nov-91	P415989	6038.24	01-May-91	P416189	6039.49	02-Dec-89
P115589	6008.04	09-Jan-90	P215789	5989.26	04-Dec-91	P415989	6042.81	11-Jun-91	P416189	6035.13	16-Jan-90
P115589	6007.43	15-Jan-90	P215789	5988.28	02-Jan-92	P415989	6040.71	05-Jul-91	P416189	6038.98	12-Jul-90
P115589	6010.14	12-Jul-90	P215789	5988.22	03-Feb-92	P415989	6041.11	08-Aug-91	P416189	6039.06	10-Aug-90
P115589	6009.38	09-Aug-90	P415889	6039.35	15-Sep-89	P415989	6039.79	03-Sep-91	P416189	6037.39	10-Sep-90
P115589	6008.91	11-Sep-90	P415889	6034.23	15-Jan-90	P415989	6037.06	04-Oct-91	P416189	6037.22	03-Oct-90
P115589	6008.37	04-Oct-90	P415889	6038.83	12-Jul-90	P415989	6035.78	04-Nov-91	P416189	6035.89	05-Nov-90
P115589	6008.47	05-Nov-90	P415889	6038.62	10-Aug-90	P415989	6040.06	04-Dec-91	P416189	6036.88	04-Dec-90
P115589	6007.93	04-Oct-91	P415889	6037.38	10-Sep-90	P415989	6038.91	02-Jan-92	P416189	6032.96	04-Jan-91
P115589	6009.07	04-Nov-91	P415889	6037.13	03-Oct-90	P415989	6038.85	03-Feb-92	P416189	6033.42	02-Apr-91
P115589	6011	02-Dec-91	P415889	6036.13	05-Nov-90	P415989	5977.38	04-Feb-92	P416189	6038.27	02-May-91
P115589	6008.66	03-Jan-92	P415889	6036.23	04-Dec-90	P415989	6037.13	02-Mar-92	P416189	6042.15	11-Jun-91
P115589	6008.52	03-Feb-92	P415889	6033.52	04-Jan-91	P416089	6048.65	15-Sep-89	P416189	6047.95	08-Jul-91
P115589	6007.17	02-Mar-92	P415889	6032.89	02-Apr-91	P416089	6041.57	16-Jan-90	P416189	6039.64	08-Aug-91
P115689	5999.86	08-Aug-91	P415889	6035.52	01-May-91	P416089	6047.14	12-Jul-90	P416189	6038.45	05-Sep-91
P115689	5997.22	04-Sep-91	P415889	6040.6	11-Jun-91	P416089	6045.93	10-Aug-90	P416189	6035.5	04-Oct-91

Table 2.3

Selected Piezometer and Groundwater Monitor Wells  
Water Level Elevations through March 5, 1992

<u>Well No.</u>	<u>Elevation</u>	<u>Date</u>	<u>Well No.</u>	<u>Elevation</u>	<u>Date</u>	<u>Well No.</u>	<u>Elevation</u>	<u>Date</u>	<u>Well No.</u>	<u>Elevation</u>	<u>Date</u>
P416189	6034.57	05-Nov-91	P416389	6051.28	11-Jun-91	P416589	6015.71	04-Oct-90	P416789	6001.81	03-Feb-92
P416189	6038.04	02-Jan-92	P416389	6046.24	05-Jul-91	P416589	6015.49	05-Nov-90	P416789	6001.64	02-Mar-92
P416189	6038.12	03-Feb-92	P416389	6046.5	08-Aug-91	P416589	6015.38	05-Dec-90	P416889	6000.23	16-Jan-90
P416189	6034.98	02-Mar-92	P416389	6044.01	05-Sep-91	P416589	6014.09	03-Jan-91	P416889	6001.81	12-Jul-90
P416289	6024.35	16-Jan-90	P416389	6040.02	04-Oct-91	P416589	6013.25	02-Apr-91	P416889	6001.51	10-Aug-90
P416289	6027.47	12-Jul-90	P416389	6039.12	06-Nov-91	P416589	6042.81	02-May-91	P416889	6000.96	10-Sep-90
P416289	6028.03	10-Aug-90	P416389	6045.27	02-Dec-91	P416589	6018.13	11-Jun-91	P416889	6000.81	04-Oct-90
P416289	6026.63	10-Sep-90	P416389	6043.72	02-Jan-92	P416589	6016.99	05-Jul-91	P416889	6001.01	05-Nov-90
P416289	6026.74	04-Oct-90	P416389	6044.05	03-Feb-92	P416589	6016.36	08-Aug-91	P416889	6000.71	05-Dec-90
P416289	6026.03	05-Nov-90	P416389	6040.93	02-Mar-92	P416589	6030.54	03-Sep-91	P416889	6000.01	03-Jan-91
P416289	6023.63	03-Jan-91	P416489	6030.16	16-Jan-90	P416589	6015.05	04-Oct-91	P416889	5999.98	02-Apr-91
P416289	6023.5	02-Apr-91	P416489	6033.32	12-Jul-90	P416589	6014.31	05-Nov-91	P416889	6001.93	02-May-91
P416289	6025.99	02-May-91	P416489	6033.75	10-Aug-90	P416589	6015.8	02-Dec-91	P416889	6004.33	07-Jun-91
P416289	6028.84	07-Jun-91	P416489	6032	10-Sep-90	P416589	6015.76	02-Jan-92	P416889	6001.77	05-Jul-91
P416289	6027.59	05-Jul-91	P416489	6031.75	04-Oct-90	P416589	6014.94	03-Feb-92	P416889	6002.64	08-Aug-91
P416289	6027.82	08-Aug-91	P416489	6030.72	05-Nov-90	P416589	6014.57	02-Mar-92	P416889	6001.28	03-Sep-91
P416289	6027.49	05-Sep-91	P416489	6031.54	05-Dec-90	P416789	6001.57	16-Jan-90	P416889	6000.65	07-Oct-91
P416289	6025.64	04-Oct-91	P416489	6028.57	04-Jan-91	P416789	6002.99	12-Jul-90	P416889	6000.53	05-Nov-91
P416289	6024.33	05-Nov-91	P416489	6028.05	02-Apr-91	P416789	6002.79	10-Aug-90	P416889	6002.67	02-Dec-91
P416289	6027.17	04-Dec-91	P416489	6050.15	02-May-91	P416789	6002.26	10-Sep-90	P416889	6001.04	02-Jan-92
P416289	6026.48	03-Jan-92	P416489	6039.73	11-Jun-91	P416789	6002.08	04-Oct-90	P416889	6000.71	03-Feb-92
P416289	6025.9	03-Feb-92	P416489	6034.98	05-Jul-91	P416789	6001.87	05-Nov-90	P416889	6000.21	02-Mar-92
P416289	6024.9	02-Mar-92	P416489	6034.17	08-Aug-91	P416789	6001.91	05-Dec-90	P218089	5978.41	17-Jan-89
P416389	6048.19	15-Sep-89	P416489	6033.45	03-Sep-91	P416789	6001.63	03-Jan-91	P218089	5979.25	01-Dec-89
P416389	6039.8	16-Jan-90	P416489	6030.41	04-Oct-91	P416789	6001.42	02-Apr-91	P218089	5978.41	17-Jan-90
P416389	6044.54	12-Jul-90	P416489	6029.3	05-Nov-91	P416789	6002.82	02-May-91	P218089	5979.03	14-Feb-90
P416389	6044.86	10-Aug-90	P416489	6034.69	02-Dec-91	P416789	6005.92	11-Jun-91	P218089	5982.1	25-Apr-90
P416389	6042.64	10-Sep-90	P416489	6033.22	02-Jan-92	P416789	6002.94	05-Jul-91	P218089	5981.73	31-May-90
P416389	6042.24	04-Oct-90	P416489	6033.25	03-Feb-92	P416789	6004.15	08-Aug-91	P218089	5977.81	11-Jul-90
P416389	6040.91	05-Nov-90	P416489	6030.96	02-Mar-92	P416789	6002.54	03-Sep-91	P218089	5978.73	13-Aug-90
P416389	6040.57	05-Dec-90	P416589	6014.33	16-Jan-90	P416789	6001.77	07-Oct-91	P218089	5978.73	13-Aug-90
P416389	6037.76	04-Jan-91	P416589	6016.05	12-Jul-90	P416789	6001.6	05-Nov-91	P218089	5977.98	03-Oct-90
P416389	6037.68	02-Apr-91	P416589	6016.78	10-Aug-90	P416789	6004.04	02-Dec-91	P218089	5977.98	03-Oct-90
P416389	6043.47	01-May-91	P416589	6015.94	10-Sep-90	P416789	6002.24	02-Jan-92	P218089	5978.04	22-Oct-90

Table 2.3

Selected Piezometer and Groundwater Monitor Wells  
Water Level Elevations through March 5, 1992

<u>Well No.</u>	<u>Elevation</u>	<u>Date</u>	<u>Well No.</u>	<u>Elevation</u>	<u>Date</u>	<u>Well No.</u>	<u>Elevation</u>	<u>Date</u>	<u>Well No.</u>	<u>Elevation</u>	<u>Date</u>
P218089	5978.04	22-Oct-90	P218089	5979.33	26-Feb-92	P119389	6007.23	10-Aug-90	P419689	6004.19	05-Sep-91
P218089	5987.55	04-Jan-91	P418289	6008.5	07-Oct-89	P119389	6007.33	04-Sep-90	P419689	6003.55	04-Nov-91
P218089	5987.55	04-Jan-91	P418289	6007.71	14-Dec-89	P119389	6007.46	02-Nov-90	P419689	6006.02	03-Dec-91
P218089	5987.55	04-Jan-91	P418289	6007.95	16-Jan-90	P119389	6006.72	04-Jan-91	P419689	6003.77	07-Jan-92
P218089	5987.55	04-Jan-91	P418289	6013.08	22-Mar-90	P119389	6007.35	07-Jun-91	P419689	6003.71	06-Feb-92
P218089	5981.26	11-Jun-91	P418289	6012.88	11-Apr-90	P119389	6007.93	03-Jul-91	P419689	6002.95	02-Mar-92
P218089	5981.26	11-Jun-91	P418289	6010.82	19-May-90	P119389	6008.33	02-Aug-91	P220089	6002.21	16-Apr-90
P218089	5977.87	03-Jul-91	P418289	6010.95	12-Jul-90	P119389	6008.36	04-Sep-91	P220089	5999.39	07-Jun-90
P218089	5977.87	03-Jul-91	P418289	6009.42	11-Sep-90	P119389	6007.88	01-Oct-91	P220089	5998.72	12-Jul-90
P218089	5978.45	08-Aug-91	P418289	6008.99	04-Oct-90	P119389	6007.6	04-Nov-91	P220089	5997.75	24-Sep-90
P218089	5978.45	08-Aug-91	P418289	6010.11	19-Nov-90	P119389	6008.1	03-Dec-91	P220089	5997.29	04-Oct-90
P218089	5977.91	22-Aug-91	P418289	6006.67	03-Jan-91	P119389	6007.94	08-Jan-92	P220089	5997.57	30-Nov-90
P218089	5977.91	22-Aug-91	P418289	6007.63	19-Mar-91	P119389	6007.76	06-Feb-92	P220089	5996.23	04-Jan-91
P218089	5977.46	07-Oct-91	P418289	6010.82	18-Jun-91	P119389	6007.18	02-Mar-92	P220089	5996.55	19-Mar-91
P218089	5977.46	07-Oct-91	P418289	6009.27	05-Jul-91	P419689	6004.62	15-Aug-90	P220089	5996.46	02-Apr-91
P218089	5977.5	16-Oct-91	P418289	6010.96	16-Aug-91	P419689	6004.05	14-Sep-90	P220089	6002.03	12-Jun-91
P218089	5977.5	16-Oct-91	P418289	6009.6	11-Nov-91	P419689	6004.09	03-Oct-90	P220089	5999.72	05-Jul-91
P218089	5981.63	08-Jan-92	P418289	6008.37	09-Jan-92	P419689	6003.52	02-Nov-90	P220089	5999.88	13-Aug-91
P218089	5981.63	08-Jan-92	P418289	6008.85	05-Feb-92	P419689	6002.66	04-Jan-91	P220089	5997.16	04-Oct-91
P218089	5981.6	15-Jan-92	P119389	5995.3	18-Jan-90	P419689	6006.24	20-Jun-91	P220089	5996.37	22-Oct-91
P218089	5981.6	15-Jan-92	P119389	5996.58	26-Apr-90	P419689	6004.81	03-Jul-91	P220089	5997.74	09-Jan-92
P218089	5979.33	26-Feb-92	P119389	6005.89	11-Jul-90	P419689	6006.56	09-Aug-91	P220089	5997.62	04-Feb-92

sandstone is not in direct contact with the surficial materials in the OU13 area. Unconfined groundwater flow occurs in the uppermost hydrostratigraphic unit. Generally, the groundwater flows along the contact of the surficial materials with the claystones and silty claystones of the Arapahoe Formation from west to east, with minor diversions along drainages. Although the saturated thickness may thin considerably during the winter months, wells are rarely dry in the OU13 area.

If the uppermost Arapahoe sandstone is present in the OU13 area where boreholes encounter claystones at the top of the Arapahoe Formation, then the claystones form a confining layer and the sandstones are confined aquifers, as is the case elsewhere at the RFP.

#### 2.1.4.4 Water Level Map

Monthly water levels measured in the wells within OU13 and the surrounding area indicate that overall saturated thicknesses were greatest in June of 1991 (Tables 2.1 and 2.3). A high water level map was generated from water levels measured June 7-20, 1991. This map is presented here as Figure 2-31. As the figure indicates, groundwater in the uppermost hydrostratigraphic unit flows generally eastward. Since the water levels were measured over a two-week period, minor features on the potentiometric surface could be the results of temporal water level variations in individual wells.

Monthly water levels measured in the wells within OU13 and the surrounding area indicate that overall saturated thicknesses were the least in January 1991 (Tables 2.1 and 2.3). A low water level map is presented here as Figure 2-32. Comparison of high water table contours on Figure 2-31 with low water table contours on Figure 2-32 shows that the hydraulic gradient varies with water table elevation. This change may be related to the influence of the paleotopography of the pediment surface. Significant influence of the paleotopography on hydraulic gradients (hence on

flow direction) is also indicated by the geologic cross-sections (Figures 2-26 through 2-30), where the low water table is seen to approach the top of the Arapahoe Formation in some areas.

No water level data are available for the lower hydrostratigraphic units believed to be present under OU13 as confined aquifers. Water levels measured in bedrock wells in other areas of the RFP consistently indicate a strong downward component in the hydraulic gradient (EG&G, 1991c). This is in keeping with the fact that the RFP site is on a topographic high and is within a regional recharge area.

#### 2.1.4.5 Hydraulic Conductivities

No values of hydraulic conductivity are available for the OU13 area.

#### 2.1.5 Surface Water Hydrology

The surface-water drainage areas from OU13 were analyzed using the information presented by Lee Wan and Associates (LWA)(Lee, 1987), Wright Water Engineers, Inc. (WWE, 1991) and EG&G (EG&G, 1991e; EG&G, 1991f; EG&G, 1991g; EG&G, 1992h). For the purposes of this analysis, the outer boundary of the OU13 area (hereafter called the OU13 boundary) was superimposed over the drainage-basin map (Figure 1-4) to assess which drainage areas are located wholly or partly within the OU13 boundary. From this analysis, flow paths of the runoff leaving OU13 were tracked through ditches, swales, culverts, storm sewer systems, and ponds to evaluate what areas located outside the OU13 boundary are receiving runoff originating from within the OU13 boundary.



The major drainage basins that receive runoff from OU13 are:

- 1) North Walnut Creek
- 2) South Walnut Creek
  - A. Upper South Walnut Creek
  - B. Lower South Walnut Creek

Figure 2-33 shows the OU13 boundary with the surface-water drainage basins outlined and the current primary drainage paths indicated. Figure 2-34 shows the historic and current drainage paths in the central part of OU13. These drainage paths have been identified using the information obtained from the June 1955 aerial photography (EPA, 1988d). The flow paths were further verified using stereo-paired aerial photographs flown on May 11, 1955.

Two major areas have changed since 1955. The first modification to the "historic" drainage paths was to the upper South Walnut Creek natural drainageway. The drainageway historically extended west and south to the intersection of Central Avenue and Eighth Street. The upper segment of this drainageway was filled between June 1955 and October 1964 from Tenth Street to the intersection of Central Avenue and Eighth Street for the construction of parking areas associated with Buildings 707 and 750. The runoff that previously entered this part of the drainageway is now conveyed through a system of storm sewers, culverts and open ditches along the north side of Central Avenue, discharging into upper South Walnut Creek upstream of Northeast Perimeter Road.

The second major modification to the historic drainage paths was to the unnamed tributary to North Walnut Creek between the intersection of Sage Avenue and Fourth Street, and the intersection of Patrol Road and Sixth Street. The modifications to this segment were done in stages, beginning with the construction of Sage Avenue in 1969, followed by the construction of Parking Area No. 371, and Buildings 371 and 374. Based on the inspection of the aerial photographs (EPA, 1988d), the unnamed tributary to North Walnut Creek was re-aligned due to

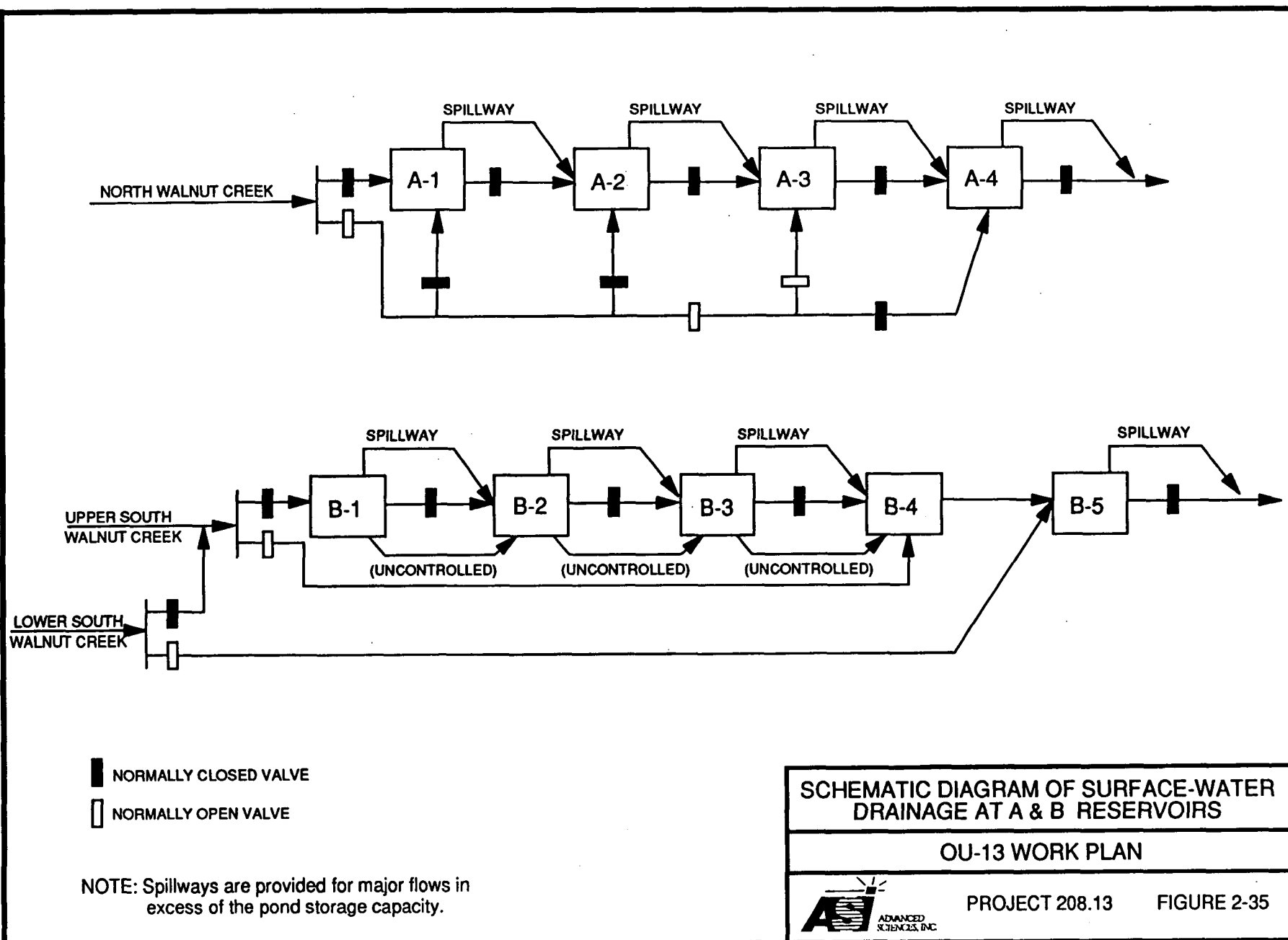
the placement of fill material north of Sage Avenue in the 1971 to 1973 timeframe. This tributary was then channelized through culverts and open ditches along the north side of Sage Avenue, turning north at Sixth Street. The channelized segment of the tributary currently discharges into the natural section northwest of the intersection of Patrol Road and Sixth Avenue.

Figure 1-5 provides an overall schematic diagram of the RFP site area surface-water drainage system with the boundary of OU13 indicated. This map indicates the layout of the different major drainageways and shows the location of the OU13 boundary in relation to these surface-water drainage systems. Figure 2-35 provides a schematic diagram of surface-water diversion structures at the A-series and B-series ponds.

#### 2.1.5.1 North Walnut Creek

The North Walnut Creek basin collects drainage from the northern part of the RFP CA, including approximately 18.3 acres located within the OU13 boundary. Runoff in the upper part normally bypasses Ponds A-1 and A-2 and is collected in Pond A-3 (see Figure 2-34). Water may be diverted to Ponds A-1 and A-2, which are used exclusively for spill control (EG&G, 1991g). Pond A-4 is the terminal pond on North Walnut Creek and receives water released from Pond A-3 (EG&G, 1991g). Water from Pond A-4 is discharged to North Walnut Creek in accordance with the RFP National Pollutant Discharge Elimination System (NPDES) permit, the Federal Facilities Compliance Agreement (FFCA), and the Agreement in Principle (AIP)(EG&G,1991g). North Walnut Creek is a perennial stream, whereas the tributary that carries the runoff from OU13 to North Walnut Creek is an intermittent stream, with flow occurring primarily after precipitation and snowmelt events.

The effect of OU13 on surface-water and sediments cannot be easily separated from the effects of IHSSs in other OUs. The surface-water runoff leaving OU13 flows north through OU8 and



OU10 before reaching North Walnut Creek. Upon reaching North Walnut Creek, the runoff enters OU6 which encompasses the A-series ponds. Other OUs having IHSSs also located within the OU13 boundary are OU6, OU8, OU9, OU10, OU12, OU14, OU15, and OU16. The OU13 IHSSs located within the North Walnut Creek drainage basin are numbers 117.1, 128, 134, 158, 171, and 186. Table 2.4 provides a listing of each operable unit whose boundary overlaps with the OU13 boundary (EG&G, 1991d). Also, each IHSS associated with these operable units are listed and the drainage basin is identified. The listed IHSSs are either located within the OU13 boundary, or are located in an area that drains to one of the surface-water monitoring sites.

#### 2.1.5.2 South Walnut Creek

South Walnut Creek begins on Rocky Flats property and receives the majority of stormwater runoff from the site within the OU13 boundary. This basin can be further divided into upper South Walnut Creek and lower South Walnut Creek drainage basins (LWA, 1987) (Figures 2-32 and 2-34). Lower South Walnut Creek is an intermittent stream and upper South Walnut Creek is a perennial stream.

The upper South Walnut Creek drainage basin receives storm runoff from approximately 24.8 acres within OU13. This runoff flows primarily along a small manmade ditch on the north side of Central Avenue (not the large ditch on the south side) and into a storm sewer system which discharges on the east side of the RFP Protected Area into the natural channel of South Walnut Creek. This channel then drains east to a culvert system under the Northeast Perimeter Road and into a diversion structure located just upstream from Pond B-1 (see Figure 2-34). This runoff is normally diverted around Ponds B-1, B-2, and B-3 through a bypass line to Pond B-4, although it may be diverted into Pond B-1 (see Figure 2-34). Pond B-4 has limited storage capacity and generally passes water directly to Pond B-5 (EG&G, 1991g).

Table 2.4  
Relationship of Other OUs and IHSS's to OU13

OU Number	IHSS Number	Drainage Basin
OU5 <sup>1)</sup>	---	South Interceptor Ditch
OU6 <sup>1)</sup>	141	upper South Walnut Creek
	165 <sup>2)</sup>	upper South Walnut Creek
OU8	118.2 <sup>2)</sup>	upper South Walnut Creek
	123.1 <sup>2)</sup>	upper South Walnut Creek
	123.2 <sup>2)</sup>	upper South Walnut Creek
	150.4 <sup>2)</sup>	upper South Walnut Creek
	150.5 <sup>2)</sup>	upper South Walnut Creek
	150.7 <sup>2)</sup>	upper South Walnut Creek
	159 <sup>2)</sup>	upper South Walnut Creek
	172	North Walnut Creek and upper and lower South Walnut Creek
	173 <sup>2)</sup>	upper South Walnut Creek
	184 <sup>2)</sup>	upper South Walnut Creek
OU9	121	North Walnut Creek and lower South Walnut Creek
OU10	129	lower South Walnut Creek
	181	North Walnut Creek and upper South Walnut Creek
	213	lower South Walnut Creek
OU12	116.2 <sup>2)</sup>	lower South Walnut Creek
	120.1 <sup>2)</sup>	lower South Walnut Creek
	120.2 <sup>2)</sup>	lower South Walnut Creek
	147.1	upper South Walnut Creek
	157.2 <sup>2)</sup>	lower South Walnut Creek

Table 2.4

Relationship of Other OUs to OU13 - Concluded

OU Number	IHSS Number	Drainage Basin
OU14	156.1	North Walnut Creek
	160	lower South Walnut Creek
	161	lower South Walnut Creek
	162	upper and lower South Walnut Creek
	164.2	lower South Walnut Creek
	164.3	lower South Walnut Creek
OU15	179	lower South Walnut Creek
	180 <sup>2)</sup>	lower South Walnut Creek
OU16	185 <sup>2)</sup>	upper South Walnut Creek
	192 <sup>2)</sup>	upper South Walnut Creek
	193	lower South Walnut Creek
	194 <sup>2)</sup>	upper South Walnut Creek
	196 <sup>2)</sup>	lower South Walnut Creek

- 1) Located downstream of OU13.
- 2) Located within the area that drains onto OU13. Not located within the OU13 boundary.

Historically Ponds B-1 and B-2 have been used as spill-control ponds (EG&G, 1991g) to receive potentially contaminated surface water from the South Walnut Creek basin. The goal is to keep water levels in Pond B-1 and B-2 low in order to maintain capacity for spill control and dam safety. Pond B-3 collects effluent discharged via a pipeline from the sewage treatment plant. Water in Pond B-3 is discharged in accordance with provisions of the Rocky Flats Plant NPDES permit to Pond B-4 and thence to Pond B-5.

Pond B-5 is the terminal pond on South Walnut Creek. Prior to 1989, water from Pond B-5 was discharged through a valve directly into South Walnut Creek. From early 1989 until late 1990, the water was treated prior to discharge. Beginning in late 1990, excess water in Pond B-5 has been transferred by pipeline to Pond A-4, where it may be treated if necessary and discharged to Walnut Creek according to the NPDES permit, the FFCA, and the AIP (EG&G, 1991g).

The surface-water runoff leaving OU13 flows east into OU6, which encompasses the B-series ponds located along South Walnut Creek (Figures 1-4 and 1-5). The OU13 IHSSs which are located within the upper South Walnut Creek sub-basin are numbers 117.1, 117.2, 158, 190, and 191.

The lower South Walnut Creek drainage basin receives storm runoff from approximately 25.5 acres within OU13. The primary drainage structure of this drainage basin is the manmade drainage ditch along the south side of Central Avenue. Runoff from this basin is conveyed to a diversion structure located on the west side of the Northeast Perimeter Road. This runoff can be diverted north to the Upper South Walnut Creek drainage subsystem or east to South Walnut Creek between Ponds B-4 and B-5 (see Figure 2-35).

#### 2.1.6 Air

#### Meteorological Monitoring

The RFP air quality and meteorological monitoring programs are designed to collect data on the entire site and are not specific to OU13. Meteorological data is being collected at one location at the RFP. Telemetered wind measurements are collected at the RFP 61-Meter Meteorological Tower (Figure 1-2) (EG&G, 1990a).

### 2.2 NATURE AND EXTENT OF CONTAMINATION

The description of the nature and extent of contamination presented in this subsection is based on historical reports, review of historical photographs, site visits, interviews with former and present the RFP employees, and review of analytical data obtained from the Rocky Flats Environmental Database System (RFEDS). All available analytical data for air, surface water, sediments, borehole samples, and groundwater are presented in Appendices C, D, E, and F. Validated data are identified in the tables in these appendices and in the summary tables in this subsection by a V (validated and valid), an R (validated and rejected), or an A (validated and acceptable with qualifications). J indicates that data are present but below the detection limit, and B indicates that the constituent was also detected in laboratory blanks.

Analytical data available from RFEDS for the area in and around OU13 are limited, and much of the available analytical data have not been validated. The quality of the unvalidated data is unknown and is included here for planning purposes only. Without this data, the amount of information available would not be sufficient for making initial decisions regarding the nature and extent of contamination and for determining the number and locations of sampling points for the RFI/RI.



The available analytical data presented in this subsection are compared to background data to characterize the nature and extent of contamination. The background data discussed in this subsection are those provided in the Background Geochemical Characterization Report (EG&G, 1990d) which was submitted to, and approved by, EPA and CDH. The Final Background Geochemical Characterization Report was delivered to EPA and CDH in September 1992. The Background Geochemical Characterization Report identifies separate environmental media, and through statistical analyses provides background concentrations for each media, or group of media. In that report, where sufficient data were available tolerance intervals were calculated for each parameter. When there was an insufficient number of samples or an insufficient number of detectable concentrations for a given constituent for the calculation of tolerance intervals, the Background Geochemical Characterization Report provides maximum and minimum detected values. The analytical data obtained for OU13 were compared to the upper tolerance limit (or both upper and lower tolerance limits for pH) or the maximum detected concentration for each parameter to determine if the concentration exceeded background. In addition, when the upper tolerance limit was exceeded, the concentrations were compared to the maximum concentration detected in background samples as an additional indicator of whether the concentration detected may be evidence of a release to the environment. When the pH of a sample was greater than the upper tolerance limit or less than the lower tolerance limit, it was also compared to the range of background values.

Background data for media relevant to the discussion of the nature and extent of contamination associated with OU13 are summarized in Tables 2.5, 2.6 and 2.7. The concentrations for upper tolerance limit reported in these tables are calculated. Therefore, the number of digits do not reflect accuracy of analytical methods. Background data in these tables are interim values that may change as background geochemical characterization progresses. For the purposes of this Work Plan, analytical data for surficial materials identified as artificial fill on borehole logs were compared to background data for North Rocky Flats Alluvium. Regardless of whether borehole

**TABLE 2.5**  
**BACKGROUND CONCENTRATIONS FOR ROCKY FLATS ALLUVIAL GROUNDWATER**

**Dissolved Metals**

	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium	Cesium	Chromium	Cobalt	Copper	Iron	Lead	Lithium
Upper Tolerance Limit (mg/l)	..	..	..	..	..	..	43.5726	..	..	..	..	..	..	..
Maximum Concentration (mg/l)	0.2U	0.5U	0.01U	0.116U	0.005U	0.011U	75.0	2.5U	0.02U	0.05U	0.0201U	0.266	0.0054	0.1U

	Magnesium	Manganese	Mercury	Molybdenum	Nickel	Potassium	Selenium	Silver	Sodium	Strontium	Thallium	Tin	Vanadium	Zinc
Upper Tolerance Limit (mg/l)	..	0.1356	..	..	..	..	..	..	8.8696	..	..	..	..	..
Maximum Concentration (mg/l)	5.79	0.268	0.0002U	0.5U	0.0432	7.73	0.05U	0.03U	11.0	1.0U	0.04U	1.0U	0.05U	0.141U

**Inorganic Constituents**

	Bicarbonate	Carbonate	Chloride <sup>1</sup>	Cyanide	pH	Nitrate/ Nitrite	Sulfate
Upper Tolerance Limit (mg/l except pH)	146.7346	..	7.5743	..	8.3193	2.1734	25.2270
Lower Tolerance Limit (mg/l except pH)	NA	NA	NA	NA	6.0781	NA	NA
Maximum Concentration (mg/l except pH)	450.0	5.0U	16.0	0.01U	8.6	..	..
Minimum Concentration (mg/l except pH)	NA	NA	NA	NA	6.3	NA	NA

**Radionuclides**

	Americium- 241	Cesium- 137	Alpha	Beta	Plutonium-239	Radium-226	Radium-228	Strontium-90	Tritium	Uranium -233,234	Uranium- 235	Uranium -238
Upper Tolerance Limit (pCi/l)	0.0197	0.6237	7.7990	8.7694	0.0118	..	..	1.2300	454.2380	..	0.1601	0.9806
Maximum Concentration (pCi/l)	0.031	0.5	12.0	13.0	0.017	170.0		2.13	390.0	0.1	0.23	1.19

NA = Not applicable    .. = Value not calculated    U = Concentration below detection limit    <sup>1</sup> Value for North Rocky Flats Alluvial Groundwater

**TABLE 2.6**  
**BACKGROUND CONCENTRATIONS FOR ROCKY FLATS ALLUVIUM**

**Metals**

	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium <sup>1</sup>	Cesium	Chromium <sup>1</sup>	Cobalt	Copper <sup>1</sup>	Iron	Lead <sup>1</sup>	Lithium <sup>1</sup>
Upper Tolerance Limit (mg/kg)	13419.4947	..	4.2988	79.4928	4.7040	..	8430.1986	..	19.9897	..	11.1314	13753.5715	12.1546	..
Maximum Concentration (mg/kg)	40800.0	33.2U	41.7	209.0	19.0	3.2	157000.0	968.0U	69.6	28.1	16.6	33700.0	25.7	31.3

	Magnesium	Manganese	Mercury <sup>1</sup>	Molybdenum <sup>1</sup>	Nickel <sup>1</sup>	Potassium	Selenium	Silver	Sodium	Strontium <sup>1</sup>	Thallium <sup>1</sup>	Tin <sup>1</sup>	Vanadium <sup>1</sup>	Zinc <sup>1</sup>
Upper Tolerance Limit (mg/kg)	2484.2373	234.9950	..	..	21.4229	1557.9829	..	..	..	..	..	..	37.1857	39.7143
Maximum Concentration (mg/kg)	5570.0	656.0	0.32	41.0	54.2	4020.0	12.0U	40.9	4840.0U	226	5.4U	312.0	70.0	77.6

**Inorganic Constituents**

	Bicarbonate	Carbonate	Chloride	Cyanide	pH	Nitrate/ Nitrite <sup>1</sup>	Sulfate
Upper Tolerance Limit (mg/kg except pH)	..	..	..	..	9.5174	..	..
Lower Tolerance Limit (mg/kg except pH)	NA	NA	NA	NA	6.3858	NA	NA
Maximum Concentration (mg/kg except pH)					9.1	4.3	
Minimum Concentration (mg/kg except pH)					7.0	NA	NA

**Radionuclides**

	Americium- 241	Cesium- 137	Alpha	Beta	Plutonium-239	Radium-226	Radium-228	Strontium-90	Tritium <sup>2</sup>	Uranium -233,234	Uranium- 235	Uranium -238
Upper Tolerance Limit (pCi/g)	0.0135	0.0669	39.3636	36.8150	0.0150	0.6513	1.9561	0.7256	0.4147	0.6558	0.0741	0.6830
Maximum Concentration (pCi/g)	0.01	0.2	42.0	44.0	0.02	0.9	2.2	1.2	0.44	3.4	0.1	3.2

NA = Not applicable    .. = Value not calculated    U = Concentration below detection limit    <sup>1</sup> Value for North Rocky Flats Alluvium    <sup>2</sup> Concentration in pCi/ml

**TABLE 2.7**  
**BACKGROUND CONCENTRATIONS FOR COLLUVIUM, WEATHERED CLAYSTONE AND WEATHERED SANDSTONE**

**Metals**

	Aluminum	Antimony	Arsenic	Barium	Beryllium	Cadmium	Calcium <sup>1</sup>	Cesium	Chromium <sup>1</sup>	Cobalt	Copper <sup>1</sup>	Iron	Lead <sup>1</sup>	Lithium <sup>1</sup>
Upper Tolerance Limit (mg/kg)	10427.7752	..	4.0203	121.8903	3.4013	..	7566.5613	..	10.3477	..	16.2533	14726.3649	18.6811	11.6003
Maximum Concentration (mg/kg)	22900.0	16.2	10.8	491.0	10.3	2.6U	44300.0	516.0U	21.3	29.7	26.7	38100.0	28.2	48.4U

	Magnesium	Manganese	Mercury <sup>1</sup>	Molybdenum <sup>1</sup>	Nickel <sup>1</sup>	Potassium	Selenium	Silver	Sodium	Strontium <sup>1</sup>	Talium <sup>1</sup>	Tin <sup>1</sup>	Vanadium <sup>1</sup>	Zinc <sup>1</sup>
Upper Tolerance Limit (mg/kg)	2799.1426	203.0125	..	13.4310	20.1842	..	..	..	..	64.0675	..	..	23.7320	62.3409
Maximum Concentration (mg/kg)	5580.0	737.0	0.44	48.4U	62.4	3090.0	12.8U	33.5	3680.0	113.0	5.0U	441.0	40.9	129.0

**Inorganic Constituents**

	Bicarbonate	Carbonate	Chloride	Cyanide	pH	Nitrate/ Nitrite <sup>1</sup>	Sulfate
Upper Tolerance Limit (mg/kg except pH)	..	..	..	..	9.5161	..	..
Lower Tolerance Limit (mg/kg except pH)	NA	NA	NA	NA	7.2914	NA	NA
Maximum Concentration (mg/kg except pH)					9.7	2.5	
Minimum Concentration (mg/kg except pH)					7.2	NA	NA

**Radionuclides**

	Americium- 241	Cesium- 137	Alpha	Beta	Plutonium-239	Radium-226	Radium-228	Strontium-90	Tritium <sup>2</sup>	Uranium -233,234	Uranium- 235	Uranium -238
Upper Tolerance Limit (pCi/g)	..	0.0745	48.4255	34.1512	0.0209	1.1379	2.0537	0.6719	0.2875	0.9830	0.1756	1.0429
Maximum Concentration (pCi/g)		0.2	48.0	34.0	0.02	1.3	2.1	0.8	0.39	2.6	0.3	2.3

NA = Not applicable    .. = Value not calculated    U = Concentration below detection limit    <sup>1</sup> Value for North Rocky Flats Samples    <sup>2</sup> Concentration in pCi/ml

logs identified bedrock as being weathered or not, all bedrock data were compared to the background data for colluvial, weathered claystone, and weathered sandstone.

Subsections 2.2.1 through 2.2.15 discuss the nature and extent of contamination associated with each IHSS within OU13. These discussions are based primarily on the documented events related to each release within an IHSS and the available analytical data for borehole and groundwater samples. Data on air monitoring and surface-water and sediment monitoring are generally not discussed on an IHSS-specific basis due to the fact that the monitoring locations for these media are such that contamination attributable to individual IHSSs cannot be defined. Summaries of the data available for these media and data requirements are provided in Subsections 2.2.16 and 2.2.17, respectively.

The analytical data for wells that were completed as piezometers are limited to borehole samples taken when the wells were drilled. The majority of the wells within the OU13 boundary were completed as piezometers. Figure 2-36 is a map of the wells in the vicinity of OU13 showing those for which analytical data were requested from RFEDS and the types of data available for each well. The data available for each well are included in Appendices C and D and are summarized in tables discussed in the following subsections.

#### 2.2.1 North Chemical Storage Site (IHSS 117.1)

There have been no documented incidents that would be likely to result in environmental impact at IHSS 117.1 (Appendix A). Excavation of a portion of the site during the construction of the Protected Area in the early 1980s uncovered machine turnings, rings, shapes, overlays, and other metal parts. The material uncovered was believed to be non-radioactive and was not oily.

It is improbable that the storage of scrap metal, construction debris, or limited chemical storage (if this occurred) had an impact on the air. No documentation regarding air monitoring in the area was found.

Well P214689 is located within this IHSS immediately north of the intersection of Seventh Street and Sage Avenue. Analytical data from this well are limited to analyses of volatile organic compounds (VOCs), metals, inorganic constituents, and radionuclides in surficial material and bedrock samples taken when the well was drilled in September 1989. Sampling and analysis of groundwater have not been performed at this well. A summary of the analytical data for borehole samples from this well is presented in Table E.1, (Appendix E). Several VOCs were detected in borehole samples from various depths in this well (Figure 2-37). Toluene, benzene, and carbon disulfide were detected in both alluvium and bedrock samples. The concentrations of these constituents do not display a clear trend of distribution with depth although the highest concentrations of toluene were detected in samples collected from 16 to 20 feet deep. Ethylbenzene and total xylenes were also detected in samples of alluvium taken at depths of 16 to 20 feet. Contamination of laboratory blanks with acetone and methylene chloride, two common laboratory contaminants, was indicated in a number of samples from this well. One sample taken from 20 to 22 feet contained 17 µg/g acetone. Laboratory blank contamination was not indicated for this sample.

Metals detected in concentrations above background in samples of alluvium include barium, cadmium, copper, iron, manganese, potassium, sodium, vanadium, and zinc. Although the concentrations detected in these samples exceeded the upper tolerance limit for background alluvium (except for cadmium and sodium for which an upper tolerance limit has not been calculated), most do not exceed the maximum background concentrations for each constituent. Cadmium, copper, and sodium concentrations in a sample taken within 3 feet of the ground surface exceeded the maximum background concentrations. Copper concentrations in samples taken from several other depths also exceeded the maximum background concentration. The

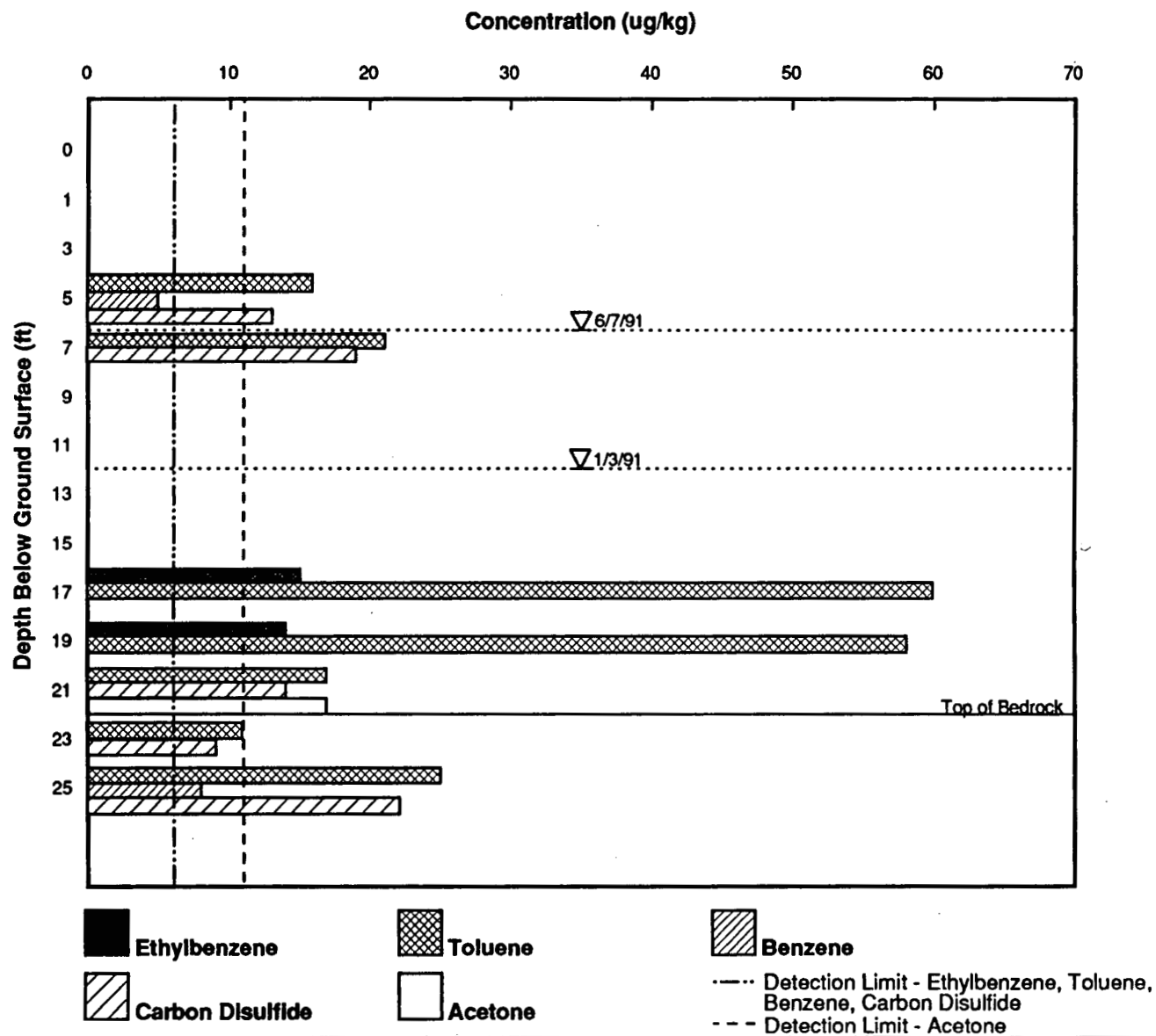


FIGURE 2-37  
DISTRIBUTION OF VOLATILE ORGANIC COMPOUNDS IN  
BOREHOLE SAMPLES FROM WELL P214689

OPERABLE UNIT NO. 13  
PHASE I RFI/RI WORK PLAN  
U.S. DEPARTMENT OF ENERGY  
Rocky Flats Plant, Golden, Colorado

copper concentrations detected, however, are comparable to those detected in borehole samples from other wells throughout OU13. Copper was also detected at a concentration exceeding the upper tolerance limit but less than the maximum background concentration in the one sample of bedrock taken from this well. The only inorganic constituent that exceeded background was nitrate/nitrite in a sample taken from depths of 0 to 3 feet.

Radionuclides detected at levels exceeding background in samples of alluvium were plutonium-239/240, radium-226, radium-228, strontium-89/90, tritium, uranium-233/234, uranium-235, and uranium-238. Only plutonium-239/240 and radium-226 were detected at levels greater than the maximum concentration detected in background samples. No radionuclides were detected at levels exceeding background in bedrock samples.

Based upon the information currently available, it is not possible to relate the contaminants detected in Well P214689 to IHSS 117.1. Since there is no documented evidence of the storage or disposal of radioactively- or chemically-contaminated materials at IHSS 117.1, it is possible that the contaminants detected in alluvium and bedrock from Well P214689 may be related to a source upgradient of this IHSS. The nearest upgradient wells for which analytical data are available are Well P114789, located approximately 450 feet west of Well P214689, and Well P115589, located approximately 600 feet to the southwest near Building 551. Analytical data are available for borehole samples taken during the drilling of these wells (Tables E.2 and E.3, Appendix E). Groundwater samples have not been collected from these wells. Several VOCs were detected in samples of alluvium from both of these wells at concentrations less than the analytical detection limit. Several of the compounds detected in Well P114789 are the same as those detected in Well P214689. Due to the distance between Wells P114789 and P115589 and Well P214689 and to the presence of other IHSSs and potential sources of contamination between these wells and Well P214689, it is not possible to identify the source of the contaminants detected in Well P214689.



More information is needed on the nature of the contamination expected to be associated with IHSS 117.1 and on other potential sources of contamination in the vicinity. Additional data on possible contamination of soils upgradient and downgradient of IHSS 117.1 are needed to determine the nature, extent and source of contamination in the area. In addition, data on upgradient and downgradient groundwater quality are lacking. As indicated on Figure 2-37, most of the zones where VOCs were detected in alluvium and bedrock at the time of drilling are below the water table in Well P214689. No data exist regarding possible contamination of groundwater in this area. The nearest downgradient well is P218089, which is located approximately 1,050 feet east of Well P214689.

Alluvium and bedrock samples were collected during the drilling of Well P218089. Groundwater samples for analyses of VOCs were collected once during 1990 and once during 1991 and for analysis of radionuclides twice during 1990 and twice during 1991 (Tables E.4 and E.5, Appendix E). Inorganic constituents were also analyzed in several of these samples. Acetone was detected in concentrations less than the detection limit in several borehole samples from this well. Contamination of laboratory blanks was not indicated for these samples. Methylene chloride was also detected in several samples, but laboratory blank contamination was indicated for these samples. Metals detected in concentrations greater than background in surficial materials were barium, calcium, chromium, copper, lead, magnesium, vanadium, and zinc. The concentrations of these metals did not exceed the maximum background concentration for alluvium. Barium, calcium, magnesium, and strontium were detected in concentrations greater than background in bedrock samples with only barium and strontium being detected in concentrations exceeding the maximum background concentration for bedrock. No inorganic constituents were detected in concentrations exceeding background in any sample. Borehole samples were not analyzed for radionuclides.

The only VOC detected in groundwater from Well P218089 was methylene chloride in the sample taken May 31, 1990. No laboratory blank contamination with methylene chloride was

indicated for this sample. Methylene chloride was also detected in several other samples, but contamination of laboratory blanks was indicated for those samples. Bicarbonate, chloride, nitrate/nitrite, and sulfate concentrations have exceeded background concentrations on at least one occasion. Radionuclides detected at levels exceeding background levels in groundwater from this well were U-233/234, U-235, and U-238 in samples taken during 1990. Analysis of uranium isotopes was not performed on samples collected during 1991. Groundwater samples taken from this well have not been analyzed for metals.

It is improbable that the storage of scrap metal, construction debris, or limited chemical storage (if this occurred) had an impact on the surface water. There are no ditches dissecting the area. The surface-water runoff from the North Chemical Storage Site (IHSS 117.1) flows northwest to the unnamed tributary to North Walnut Creek or southeast to the upper South Walnut Creek drainage ditch. The surface-water runoff flowing to the north is sampled by monitoring sites SW018 and SW093. However, these sites are located downstream 1,300 feet and 4,300 feet, respectively. Therefore, the water-quality data cannot be used to accurately interpret the impacts from this IHSS.

The drainage flowing southeast into the upper South Walnut Creek drainage ditch is sampled by monitoring site SWO23, which is located approximately 4,100 feet downstream. This water-quality data cannot be used to accurately interpret the impacts from this IHSS.

#### 2.2.2 Middle Chemical Storage Site (IHSS 117.2)

No documentation was found regarding the nature and extent of contamination that may be associated with IHSS 117.2. As described in Appendix A, several incidents occurred within this IHSS when radiologically or chemically contaminated materials were stored within the IHSS or when leaks or spills occurred which may have released contaminants to the environment. No

documentation of sampling activities or corrective action in response to these incidents was found.

It is improbable that the past spills and leaks in the area have any present impact on the air. No documentation regarding air monitoring in the area was found.

It is possible that past incidents have resulted in residual soil contamination. No documentation was found indicating soil sampling or removal in the area, except that soil analyses done at the time of the beryllium storage in 1971 concluded no significant contamination of beryllium (Lindsay and Robinson, 1971).

Analytical data for surficial materials, bedrock, and groundwater are lacking for the area in and around IHSS 117.2. Well P115689 is located near the eastern edge of the IHSS. No samples of surficial materials or bedrock were taken when this well was being drilled, and no samples of groundwater have been taken. The nearest sampling points that may provide an indication of possible contamination associated with IHSS 117.2 are Wells P115589, P213689, and P214089. Well P115589 is located approximately 250 feet upgradient of the IHSS on the west side of Building 551. Wells P213689 and P214089 are located approximately 750 feet east-southeast of the IHSS. The only analytical data available for these wells are for samples of surficial materials and bedrock taken when they were being drilled in 1989. A summary of this data is provided in Tables E.6 and E.7 (Appendix E). Well P215789 is located approximately 450 feet east-southeast of the IHSS, but no sampling has occurred at this location.

No samples of bedrock were taken from Well P115589. Acetone; 1,1,1-trichloroethane (1,1,1-TCA); 1,1,2,2-tetrachloroethene; 1,1-dichloroethane (1,1-DCA); 1,1-dichloroethene (1,1-DCE); 1,2-dichloroethene (1,2-DCE); tetrachloroethene (PCE); and trichloroethene (TCE) were detected at concentrations less than detection limits in samples of surficial materials from this well. Acetone and methylene chloride were detected in several samples, but contamination of

laboratory blanks was indicated for those samples. Metals detected in concentrations above background in samples of alluvium were arsenic, copper, manganese, potassium, vanadium, and zinc. With the exception of copper, the concentrations of these metals detected did not exceed the maximum concentrations detected in background alluvium. Copper concentrations in samples taken from depths of 16 to 28 feet exceed the maximum background concentration but are comparable to those detected in alluvium from other wells in and around OU13. The pH of a sample taken from 3 to 6 feet was less than the lower tolerance limit but within the range of background levels. All other inorganic constituents were detected in background concentrations.

Radionuclides detected at levels exceeding background in samples of alluvium from Well P115589 include plutonium-239/240, radium-226, radium-228, strontium-89/90, uranium-233/234, uranium-235, and uranium-238. The concentrations of plutonium-239/240 detected in these samples exceeded the maximum background concentration at all depths. Radium-226, strontium-89/90, and uranium-235 concentrations exceeded the maximum background concentration in several samples but these concentrations occurred sporadically with no clear trend of concentration with depth. The levels of the other radionuclides were generally within the range of concentrations detected in background samples.

Acetone was the predominant VOC detected in alluvium from the two wells downgradient of IHSS 117.2, P213689 and P214089. Acetone concentrations detected in Well P213689 ranged from 44 µg/kg to 200 µg/kg. 2-butanone (methyl ethyl ketone, MEK) was also detected in two samples at concentrations of 21 µg/kg and 43 µg/kg. Total xylenes and toluene were detected at levels less than detection limits in several samples. One sample from Well P214089 contained 140 µg/kg of acetone. Acetone and methylene chloride were detected in several other samples, but contamination of laboratory blanks was indicated for those samples. No other VOCs were detected in samples from this well. VOCs were not detected in samples of bedrock from either well.

Metal concentrations in several samples of alluvium from Well P213689 exceeded background for arsenic, copper, chromium, lead, magnesium, strontium, and zinc. Copper, strontium, and zinc concentrations in several of these samples also exceeded the maximum background concentrations for these elements. In addition, the analysis of a sample taken from 7 to 12 feet deep indicated that the concentration of mercury and lead in that sample exceeded maximum background concentrations. Analysis of a duplicate of that sample, however, resulted in the detection of concentrations of these elements that are less than maximum background concentrations. The analysis of the duplicates of that same sample detected cadmium concentrations of 27.4 µg/kg and 10.4 µg/kg. Both concentrations exceed the maximum background concentration for cadmium in alluvium. One sample of bedrock from this well was also analyzed. Concentrations of copper, lead, strontium, and zinc exceeded background, but only strontium exceeded the maximum concentration detected in background. All inorganic constituents were detected in concentrations comparable to background concentrations.

Samples of alluvium from Well P214089 contained concentrations of aluminum, antimony, arsenic, barium, calcium, copper, iron, lead, magnesium, manganese, nickel, potassium, strontium, vanadium, and zinc that exceeded background concentrations. As with samples of alluvium from other wells in the vicinity of OU13, copper concentrations in this well exceeded the maximum background concentration for most samples. Strontium and zinc concentrations also exceeded maximum background concentrations for several samples, and antimony and iron concentrations exceeded maximum background concentrations in a sample taken from 3 to 7 feet. Metal concentrations in the two bedrock samples taken from this well exceeded background for arsenic, barium, calcium, lead, magnesium, strontium, and zinc. Strontium was the only element for which the concentration detected exceeded the maximum background concentration. All inorganic constituents were detected in concentrations comparable to background concentrations.

Radionuclides detected at levels exceeding background in alluvium from Well P213689 include cesium-137, plutonium-239/240, radium-226, radium-228, tritium, uranium-233/234, uranium-235,

and uranium-238. The concentrations of most of these radionuclides did not exceed the maximum background concentration with the exception of cesium-137, plutonium-239/240 and tritium. Cesium-137 was detected in only one sample at a concentration of 0.83 pCi/g. Plutonium-239/240 was detected at activities ranging from 1.756 pCi/g in the 0 to 3 foot sample to 0.066 pCi/g in the 3 to 6.5 foot sample. Tritium activities ranged from 3,260 pCi/l in the 0 to 3 foot sample to 1,000 pCi/l in the 3 to 6.5 foot sample. Plutonium-239/240 was also detected at a concentration exceeding the maximum background concentration in a sample of alluvium collected from 7 to 12 feet but, tritium was not detected at that depth. Radium-226, radium-228, and tritium were detected in concentrations exceeding background in the one sample of bedrock from this well. The tritium concentration detected in this sample, 420 pCi/l, is three orders of magnitude greater than the background concentration for bedrock. Radionuclide analyses were not performed on samples taken from Well P214089.

Based upon the information currently available, it is not possible to attribute the potential contamination of surficial materials or bedrock from these wells to IHSS 117.2. The wells were not installed for the purpose of determining impacts from this or any other IHSS. The locations of the wells are such that soils in the vicinity of them could have been impacted by several possible sources of contaminants. The quantity and quality of the data currently available are not sufficient for determining impacts from IHSS 117.2. The concentrations of several constituents in samples from the two wells downgradient of IHSS 117.2 were higher than those detected in the upgradient well. Acetone and methyl ethyl ketone (MEK) were detected in relatively high concentrations in the downgradient wells, particularly Well P213689. There have been no documented releases of these two chemicals from IHSS 117.2. Although no contamination of laboratory blanks was indicated for these samples, detection of acetone in several other samples from these wells was attributed to laboratory contamination. It is also important to note that these data have not been validated, and validation may or may not confirm the reported results.

Concentrations of aluminum, barium, iron, lead, magnesium, and zinc were higher in samples from the downgradient wells than in the upgradient well. Although the concentrations of these elements were higher in downgradient wells and exceeded the background upper tolerance limits, the concentrations did not exceed the maximum concentration detected in background samples. Thus, it is difficult to attribute any increase in the concentration of these metals to possible releases from IHSS 117.2. Concentrations of cadmium in Well P213689 and strontium in both P213689 and P214089 are higher than those detected in P115589 and are greater than the maximum concentrations detected in background samples. The reason for these increased concentrations is not clear. There were also a few increased concentrations of antimony, chromium, mercury, and nickel reported for samples from the downgradient wells.

Similarly, the concentrations of plutonium-239, 240 and tritium were higher in samples from Well P213689 than in P115589. These radionuclides were detected in concentrations greater than the maximum background concentration in samples of surficial materials taken within 6 feet of the surface from P213689. The one sample of bedrock from this well contained concentrations of radium-226, radium-228, and tritium greater than background. The concentrations of these radionuclides in the remaining samples from this well were similar to those detected in P115589.

It is possible that there is no residual effect on the surface water due to the leaks and spills in the storage yard. However, it is possible that the unidentified leaking substance in 1971, and the aluminum nitrate in 1986 affected the surface water at the time of the incidents.

The surface-water runoff from this site flows east to the roadside ditch or the west side of Seventh Street and then north to a low point just south of Sage Avenue. A culvert carries this runoff east to the upper South Walnut Creek drainage ditch where it flows south then east, eventually discharging into Pond B1. This surface-water runoff is sampled by monitoring site SW023, which is located approximately 4,100 feet downstream. This water-quality data cannot be used to accurately interpret the impacts from this IHSS.

### 2.2.3 South Chemical Storage Site (IHSS 117.3)

As described in Appendix A, there was one documented incident of a release of material within this IHSS. On May 4, 1965, radioactively contaminated oil leaked from a glovebox contained in a wooden waste box that was being transported to the storage area from Building 776. Approximately 900 square feet of soil within the IHSS were contaminated during this incident. The composition of the oil was not determined, but based upon the fact that the glovebox originated from Building 776, it is presumed that the radioactive constituent of the oil was probably plutonium. It was documented that the contaminated soil around the waste box, except for the area underneath the waste box, was removed. The soil under the waste box was to be removed after the box was removed, but no documentation was found to confirm that this ever occurred. The storage area was subsequently modified during the construction of Tank 224 in 1974. Drainage ditches in the area were filled in, the area regraded, and a 10-foot-high berm was constructed around the tank.

The asphalt along Central Avenue was removed after the glovebox incident occurred in 1965. The path the truck took at the time of the glovebox incident from Central Avenue to the spot where the waste crate was placed is unknown and therefore the area of greatest potential for contamination in the soil would be the area at the corner of the storage area outside the berm that may not have been disturbed during the construction of the tank. The area along the south Central Avenue ditch was regraded in 1969, which was after the glovebox incident occurred.

No soil sampling or groundwater monitoring with the purpose of determining potential impacts from releases from IHSS 117.3 has been performed. Wells P414189 and P313489 were constructed in 1989 in the vicinity of this IHSS. Well P414189 is located southeast of Tank 224 near the intersection of Seventh Street and Cottonwood Avenue. No samples of surficial materials or bedrock were taken for chemical analyses at the time this well was being drilled, and groundwater has never been sampled at this location. Well P313489 is located approximately



250 feet southeast of IHSS 117.3. Samples of surficial materials and bedrock were taken during the drilling of this well. No groundwater samples have been taken. Based on the current understanding of the boundary of IHSS 117.3, Well P313489 is not downgradient of the IHSS. Analytical data for this well are provided here in an attempt to further define the extent of IHSS 117.3. A summary of the data available for Well P313489 is provided in Table E.8 (Appendix E).

Well P418289 is located upgradient of the IHSS near the northeast corner of Building 444. Surficial materials and bedrock were sampled during the drilling of this well and groundwater samples have been collected on a quarterly basis since March 1990. Monitoring Well 6186 is located downgradient of IHSS 117.3, approximately 750 to the east. Groundwater samples were collected from this well in July 1989 and quarterly since March 1990. No samples of surficial materials or bedrock were collected from this well during drilling. Tables E.9, E.10 and E.11 (Appendix E) provide a summary of the analytical data available for these wells.

Based on the information currently available for Well P418289, groundwater upgradient of IHSS 117.3 has been impacted by operations unrelated to this IHSS or other IHSSs within OU13. Several VOCs have been detected in this well since it was first monitored (Figure 2-38). In addition, 1,1-DCA has been detected in concentrations less than the detection limit in several groundwater samples from this well. Methylene chloride, acetone, and 4-methyl-2-pentanone were also detected in groundwater samples, but contamination of laboratory blanks was indicated for these samples. Mercury, uranium-233/234, and uranium-238 have been detected in groundwater from this well in concentrations exceeding background (Figures 2-39 and 2-40).

Other metals detected in groundwater in concentrations greater than background were barium, calcium, chromium, magnesium, sodium, and strontium. Bicarbonate, chloride, nitrate/nitrite, and

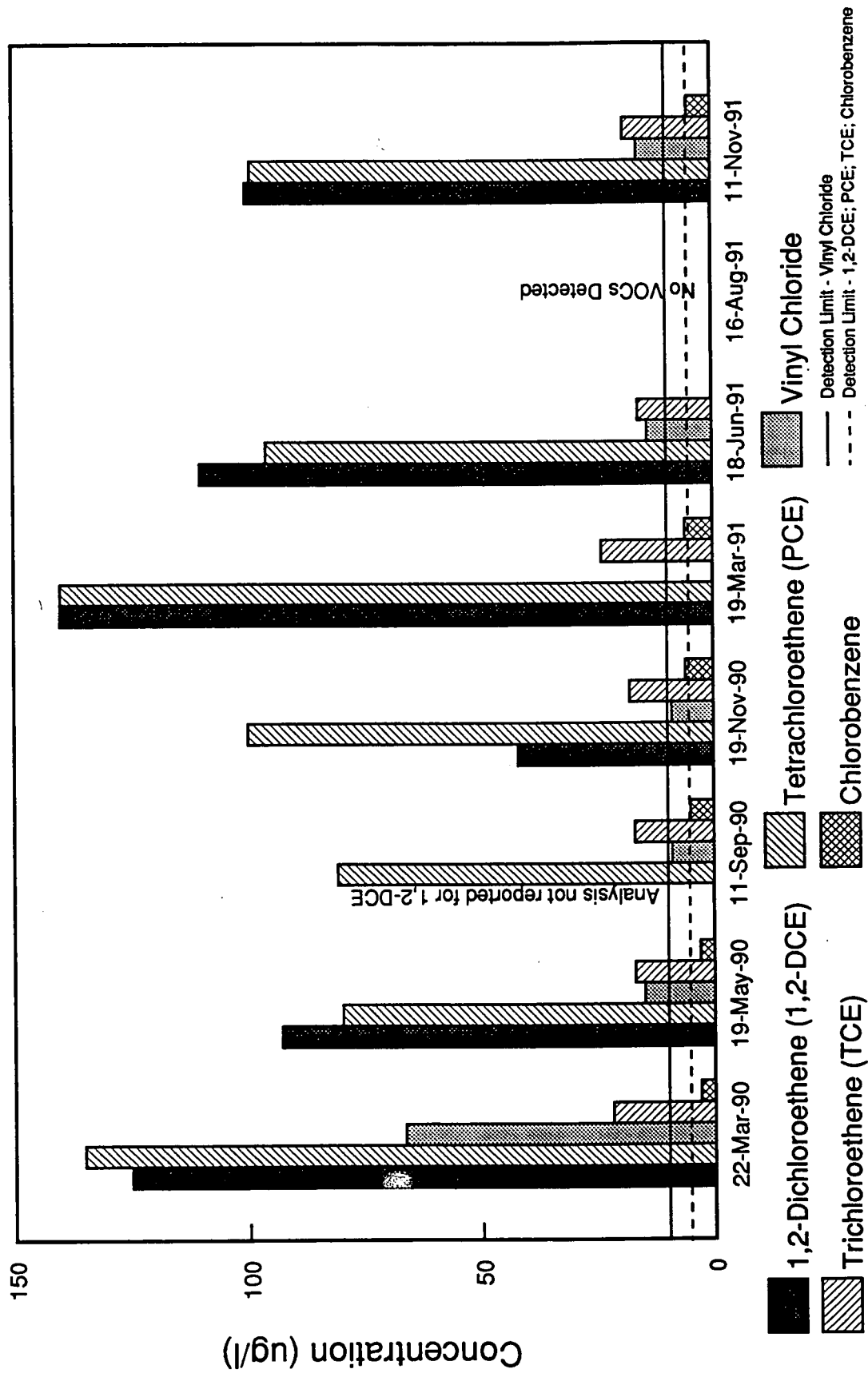
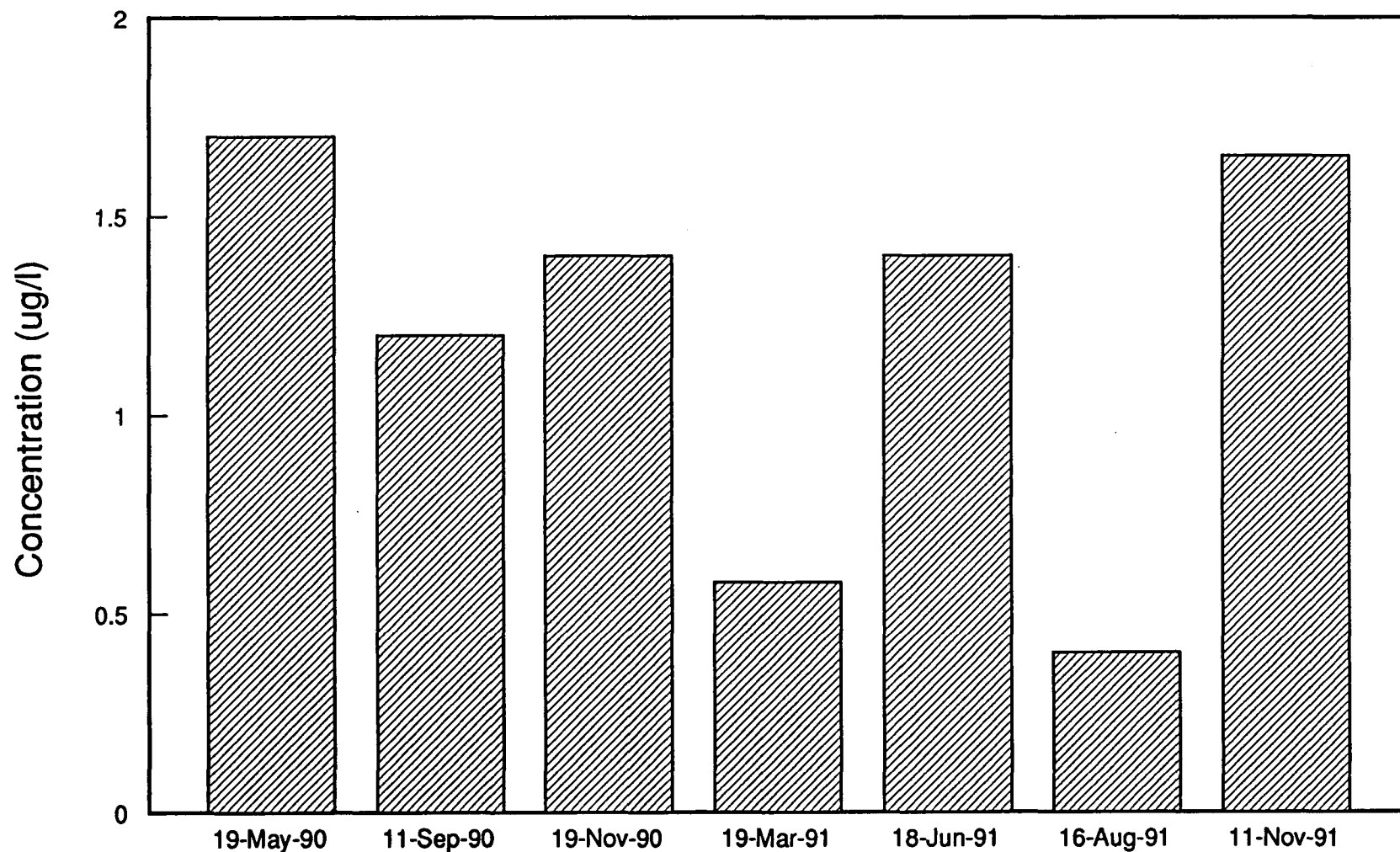


FIGURE 2-38

CONCENTRATIONS OF VOLATILE ORGANIC COMPOUNDS IN  
GROUNDWATER SAMPLES FROM WELL P418289

OPERABLE UNIT NO. 13  
PHASE I RF/RI WORK PLAN  
U.S. DEPARTMENT OF ENERGY  
Rocky Flats Plant, Golden, Colorado



Background Rocky Flats Alluvial Ground Water  
Maximum Concentration = 0.0002 mg/l (Less Than Detection Limit)

FIGURE 2-39  
CONCENTRATION OF MERCURY IN GROUNDWATER SAMPLES  
FROM WELL P418289

OPERABLE UNIT NO. 13  
PHASE I RFI/RI WORK PLAN  
U.S. DEPARTMENT OF ENERGY  
Rocky Flats Plant, Golden, Colorado

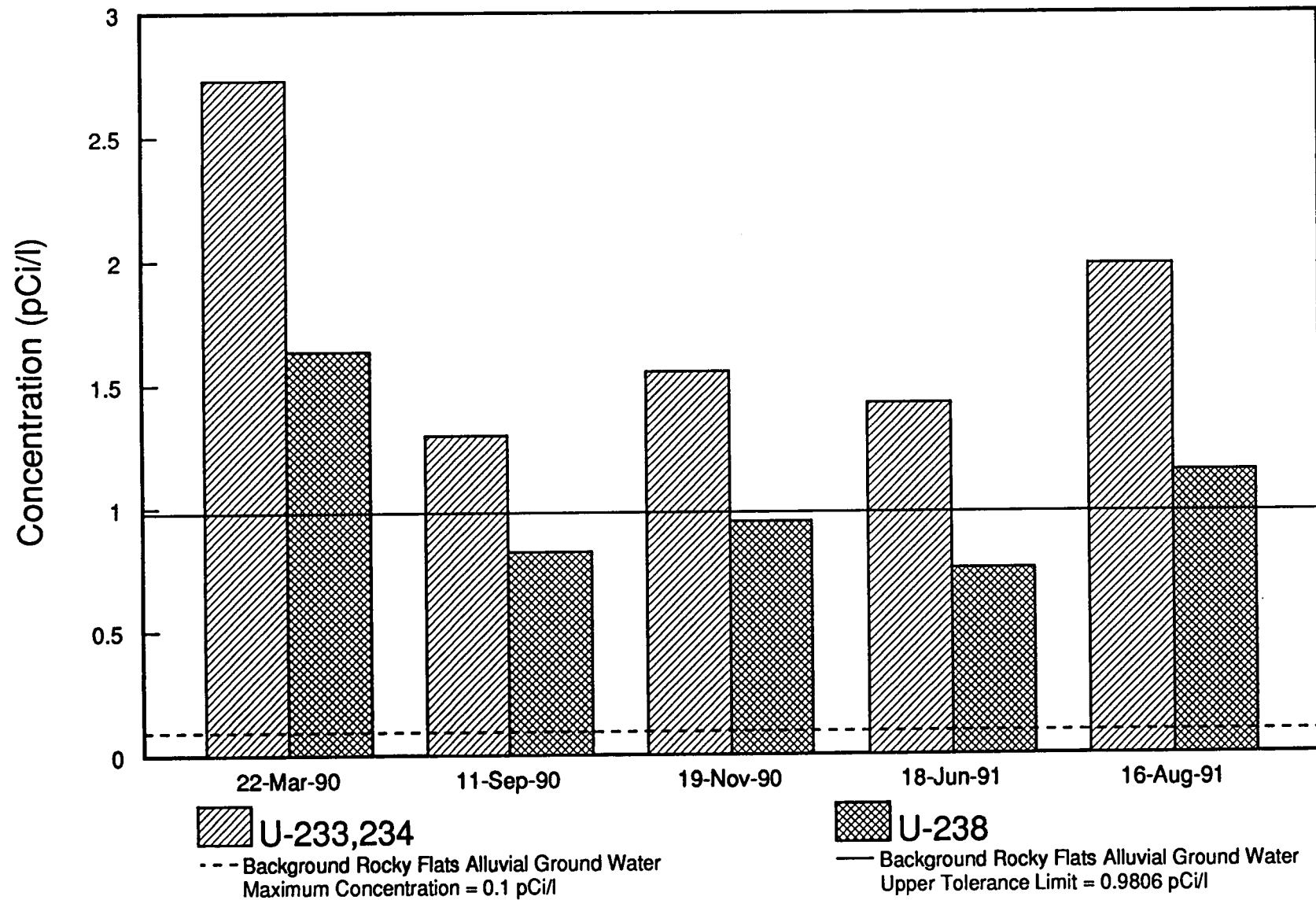


FIGURE 2-40  
CONCENTRATIONS OF URANIUM IN GROUNDWATER SAMPLES  
FROM WELL P418289

OPERABLE UNIT NO. 13  
PHASE I RF/RI WORK PLAN  
U.S. DEPARTMENT OF ENERGY  
Rocky Flats Plant, Golden, Colorado

sulfate concentrations in groundwater from this well have routinely exceeded background levels. Bicarbonate and nitrate/nitrite concentrations have generally been less than maximum background concentrations.

Analysis of samples of surficial materials and bedrock from this well did not contain detectable concentrations of any VOCs. Methylene chloride and acetone were detected in several samples, but contamination of laboratory blanks was indicated for these samples. Mercury was not detected in these borehole samples and the concentrations of uranium-233/234 and uranium-238 exceeded the upper tolerance limit for background alluvium but were less than the maximum background concentrations. Cesium-137, plutonium-239/240, radium-226, and radium-228 were also detected in concentrations exceeding background in alluvium from this well. Metals present in concentrations above background in alluvium from this well include calcium, copper, lead, magnesium, manganese, potassium, and vanadium. The concentrations of all of these elements, however, were within the range of background concentrations. The concentration of nitrate/nitrite in one sample of surficial materials in this well exceeded background.

The only VOCs detected in groundwater from Well 6186 were acetone and tetrachloroethene (PCE). With the exception of acetone in one sample, these compounds were always present in concentrations less than the analytical detection limits. Methylene chloride and acetone were detected in several samples, but contamination of laboratory blanks was indicated for these samples. Metals routinely detected in concentrations exceeding background include calcium, magnesium, and sodium. Chromium and lead were also detected in concentrations exceeding background in one sample. Bicarbonate, chloride, nitrate/nitrite, and sulfate concentrations generally exceeded background levels in all samples, but the concentrations of bicarbonate and chloride were less than the maximum background concentration. Radionuclides detected in concentrations above background include cesium-137, strontium-89/90, uranium-233/234, and uranium-238. These radionuclides were present in levels exceeding background in only one or two samples taken from this well.

Samples of surficial materials from depths of 0 to 9 feet from Well P313489 contained 1,1,1-TCA (Figure 2-41). No other VOCs were detected in borehole samples from this well. Metals detected in concentrations exceeding background concentrations in surficial materials were arsenic, barium, calcium, chromium, copper, iron, lead, magnesium, manganese, potassium, and zinc. Only lead and magnesium in the 0 to 3 foot sample (noted as artificial fill on the borehole log) exceeded the maximum background concentration for alluvium. Metals detected in concentrations exceeding background in the one sample of bedrock taken at this location were barium, copper, lead, manganese, and zinc with only barium being detected in a concentration greater than the maximum background concentration for bedrock. All inorganic constituents were detected in concentrations comparable to background concentrations.

Radionuclides present in surficial materials in concentrations greater than background were plutonium-239/240, radium-226, radium-228, strontium-89/90, uranium-233/234, uranium-235, and uranium-238. Most of these radionuclides were detected in concentrations less than the maximum background concentration. A significant exception is plutonium-239/240 which was detected at a concentration of 15.86 pCi/g in the 0 to 3 foot sample. Radionuclides detected above background in bedrock were radium-226, radium-228, strontium-89/90, uranium-233/234, and uranium-238. The concentrations of radium-226, radium-228, and strontium-89/90 were greater than the maximum concentration detected in background samples.

Due to the limited quantity and quality of the currently available data, it is not possible to associate the presence of any of the constituents discussed in the previous paragraphs in surficial materials, bedrock, or groundwater to releases from IHSS 117.3. The only data from an upgradient location are those from Well P418289. Groundwater data from this well indicate that it has been impacted by activities unrelated to any OU13 IHSS. Analyses of samples of surficial materials and bedrock taken from this well when it was drilled on November 7, 1989, do not indicate contamination which may reflect a release that occurred between the time the well was drilled and when groundwater was first sampled at this location on March 22, 1990. This

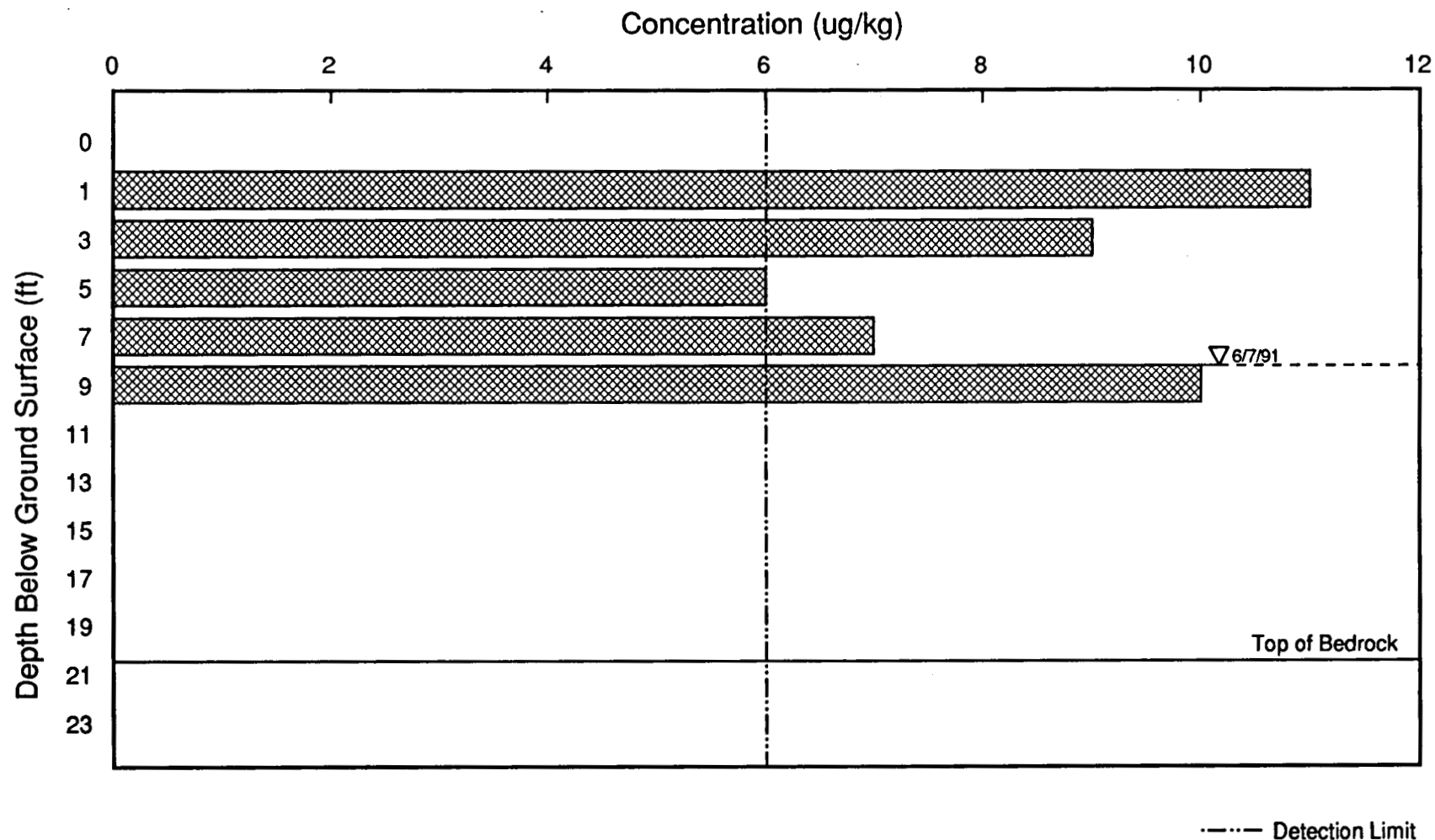


FIGURE 2-41  
DISTRIBUTION OF 1,1,1-TRICHLOROETHANE IN  
BOREHOLE SAMPLES FROM WELL P313489

OPERABLE UNIT NO. 13  
PHASE I RFI/RI WORK PLAN  
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apparent discrepancy may also indicate a plume of contaminated groundwater that had not reached this location at the time the well was drilled.

The analytical data for groundwater samples from Well 6186, the nearest downgradient monitoring well, do not clearly indicate any impact to groundwater that may be attributed to IHSS 117.3. Likewise, it is not possible to link contamination detected in borehole samples from Well P313489 to known incidents that occurred within IHSS 117.3.

Surface water in the area at the time was controlled by drainage ditches that traversed the area. Drainage on the north part of the area was into the Central Avenue ditch. The diagonal drainage ditches directed flow to the northeast then through a culvert beneath Seventh Street. Beyond Seventh Street, the flow appears to have been directed to the Central Avenue ditch. The surface water ditches were changed when Tank 224 was constructed.

At the present time, the surface-water runoff from this site flows northeast to the corner of Seventh Street and Central Avenue. A culvert under Seventh Street conveys the runoff eastward where it flows in the Central Avenue past monitoring site SW020, located approximately 1,250 feet downstream, and monitoring site SW022, located approximately 3,500 feet downstream. No analytical data for sediments was obtained downstream of this site.

The water-quality data obtained from SW020 and SW022 cannot be reliably used to interpret the impacts from this IHSS because the surface runoff from other IHSSs also drains to these monitoring sites.

#### 2.2.4 Oil Burn Pit No. 1 (IHSS 128)

Monitoring of potential environmental impacts from the burning of waste oils in this pit was limited to air monitoring conducted at the time of the experimental burn in July 1956 described



in Subsection 2.1.1.5. Documented results of sampling and analysis of surficial materials, bedrock, or surface and groundwater in the vicinity of the pit was not found.

The incident of oil burning in the area now covered by Sage Avenue and the drainage ditch left residual ash and residue on the ground surface. The composition of the material resulting from the oil burn has not been documented, although reference was made to soil samples being taken at the time of the experiment. It is unknown whether the ground surface was scarified or in another way disturbed prior to the placement of the fill and roadbase for Sage Avenue. Based on visual observations made with long-time employees and a review of photographs, the road is perhaps 10 or up to 18 feet above the original ground surface.

Two wells were installed in 1989 (P114889 and P114989) in the general proximity of this IHSS north of Sage Avenue. The borehole log from P114989 indicated approximately 9.5 feet of artificial fill while the log for P114889 indicated approximately 4 feet of fill. The fill material, however, almost certainly came from the RFP either from one of the borrow pits or from excavation during another construction activity. The borehole logs do not indicate what evidence was used to distinguish between fill and alluvium. Therefore the distinction made in the borehole logs between fill material and alluvium may or may not be accurate.

Samples of surficial materials and bedrock were taken during the drilling of Well P114889. A summary of the analytical data for these samples is presented in Table E.12 (Appendix E). No borehole samples were taken from P114989. No groundwater samples have been taken at either location. P114889 is located 150 feet east of the site of the oil burn pit. Acetone was present in a sample of alluvium taken from 9 to 11 feet. Carbon disulfide was present in a sample taken at 12 to 13.9 feet near the alluvium-bedrock contact. These two VOCs were also detected at concentrations less than the analytical detection limits in alluvium and bedrock samples at other depths. Acetone and methylene chloride were detected in a number of samples, but contamination of laboratory blanks was indicated for these samples. Several metals were detected

in concentrations exceeding the upper tolerance limit for their respective background concentrations in alluvium. The concentrations of these metals did not exceed maximum background concentrations. Many of the same metals were detected in concentrations exceeding background upper tolerance limits for bedrock, but only vanadium was detected in a concentration that exceeded the maximum background concentration for bedrock. All inorganic constituents were detected in concentrations comparable to background concentrations.

Radionuclides detected in concentrations exceeding background in samples of surficial materials were plutonium-239/240, radium-226, radium-228, uranium-233/234, and uranium-238. Only radium-226 and radium-228 were present in concentrations exceeding the maximum background concentration for each radionuclide in alluvium. The highest concentrations of radionuclides detected were in the sample collected from 0 to 3 feet. The only radionuclide present in bedrock in a concentration greater than background was radium-226, and its concentration did not exceed the maximum background concentration for bedrock.

Based upon the available analytical data for borehole samples from Well P114889, it is difficult to make any conclusions regarding the nature and extent of contamination associated with IHSS 128. Organic constituents expected to be associated with a wide variety of waste oils were not detected in borehole samples taken from this location. Assuming that the ground surface at the location of this well is the same as it was when the oil burning pit was being used, it is possible that the elevated concentrations of radionuclides detected in near-surface borehole samples could be attributable to air emissions from the burning or transport of radionuclides by surface water to this location.

The surface drainages have changed significantly over time. Prior to 1969 and the construction of Sage Avenue, the major surface water feature was the tributary to North Walnut Creek. Pond A-1 has been located on North Walnut Creek since January 1954. After Sage Avenue was constructed, surface drainage in the area was most likely toward the drainage ditch along Sage

Avenue, which may overlap with the oil burn pit area. Organic components of the oil may have migrated into the ditch, but organic components from other sources might also have migrated into the ditch. Two notable sources are the solvent burning area on the south side of the ditch (IHSS 171) and the underground 18,000-gallon gasoline tank near Building 331.

The oil burning was done on the ground surface and then backfilled. Residual material from the oil burning was subsequently disturbed as it was buried beneath the fill for Sage Avenue.

A Hazard Ranking Score (HRS) was applied to this IHSS as part of the 1986 CEARP Interim Report for the RFP. Although the description of the site and incidents were similar to the current understanding of the incident, there were significant discrepancies with the description provided above. One major discrepancy was that the CEARP indicated that Building 335 was constructed directly over the site, whereas subsequent investigation locates the site north of Building 335. The conclusion of the report was that petroleum oil sludge residues and uranium contamination are still in place. The evaluation of the HRS resulted in a Total Migration Mode score of 4.7, which reflected a non-zero score for the groundwater route (EG&G, 1992b).

The surface-water runoff from this site is collected in a sump located on the south side of Sage Avenue. A culvert carries the flow north under Sage Avenue, where an open ditch carries the flow east to the natural drainageway which flows northeast through the Protected Area and into North Walnut Creek.

The closest surface-water monitoring site is SW018, which is located approximately 1,800 feet downstream along the unnamed tributary to North Walnut Creek. Sediment sampling site SED010 is located next to SW018, but no data for this monitoring site was received. The water-quality data obtained from SW018 cannot be reliably used to interpret the impacts from this IHSS because the surface runoff from other IHSSs also drains to this monitoring site.

### 2.2.5 Lithium Metal Destruction Site (IHSS 134)

As discussed in Appendix A, IHSS 134 consists of an area used primarily for destruction of lithium, located north and east of Building 331, and an area used primarily for the destruction of magnesium, located north of Building 335 in the same area as the No. 1 oil burn pit (IHSS 128). No documentation exists as to the nature and extent of contamination that may be associated with this IHSS. No monitoring was conducted at the time the burning occurred and no sampling has been performed to determine the nature and extent of contamination that may have resulted from this burning.

The incidents of magnesium and lithium burning by the fire department were routine but not regularly scheduled. These events were typically monthly although they may have varied seasonally. No specific air sampling was done at the time of the events to monitor any releases to the atmosphere. The only atmospheric consideration noted was that the burning of magnesium caused a very bright fire that was often noted by uninvolved plant personnel and airplane pilots (Dienst and Miller, 1992). Because no records were maintained regarding the schedule or duration of the events, it is speculated that no additional information can be derived from the atmospheric consideration of the events of this IHSS.

The incidents of magnesium burning in the area of the ponds now covered by Sage Avenue and the drainage ditch north of Building 335 left residual ash and residue on the ground surface. The composition of the material resulting from the reaction with magnesium and water has not been documented. If the composition of magnesium were magnesium metal, logically magnesium hydroxide resulted, if the initial magnesium were in another form, another compound may also have resulted. In addition to magnesium metal, the fire extinguishing agents may be remnant in the soil. Different agents in addition to water were used on the magnesium. It is unknown whether the ground surface was scarified or in another way disturbed prior to the placement of the fill and roadbase for Sage Avenue. As discussed in Subsection 2.2.5 for IHSS 128, the

borehole logs for the two wells in this area do not provide conclusive evidence of the thickness of artificial fill in the area.

Analytical data for borehole samples from Well P114889 are presented in Subsection 2.2.5 for IHSS 128. These data do not indicate contamination of surficial materials or bedrock that appears to be attributable to the destruction of magnesium. Although concentrations of magnesium exceeded the upper tolerance limits for both alluvium and bedrock, the concentrations did not exceed the maximum background concentrations for magnesium in either alluvium or bedrock. The magnesium concentrations detected in borehole samples at this location are comparable to those detected in samples from boreholes throughout OU13.

The incidents of lithium burning in the area around Building 331 took place in containers on the ground. The overspray from extinguishing the burning material came into contact with the ground. The area directly behind the building was relatively active since the early 1960s, and the ground was disturbed many times. In addition to lithium hydroxide resulting from the reaction of lithium with water, other compounds would include residues from the solvents in the machining oils that coated the lithium and residues from the extinguishing agents which were used during training. The burning of lithium occurred in the general area of Building 331 in more than one spot. To the recollection of several of the RFP employees involved with the lithium and magnesium destruction, lithium was not burned in the same area as the magnesium. The specific locations in the area cannot be identified through any written record. Other activity in the area has probably impacted the soil. Prior to its being paved, tanker trucks and other heavy equipment were stored in the area.

Well P115489, was installed east of Building 331 in 1989. Analytical data are available for borehole samples taken during the drilling of this well. A summary of these data is presented in Table E.13 (Appendix E). Acetone and toluene were reported at concentrations less than the analytical detection limits in samples of surficial materials taken from Well P115489. No VOCs

were reported as being detected in the one sample of bedrock taken at this location. Acetone and methylene chloride were also detected in several samples of both surficial material and bedrock, but contamination of laboratory blanks was indicated for these samples. Several metals were detected in concentrations exceeding background in samples of surficial materials, but only copper and zinc were detected in concentrations greater than their respective maximum background concentrations. The copper concentrations detected are comparable to those detected in surficial materials from other wells within OU13. Arsenic and lead were present in concentrations greater than background in the sample of bedrock, but the concentrations of both elements did not exceed the maximum background concentrations for bedrock. All results for lithium were less than the analytical detection limit. Nitrate/nitrite concentrations in two samples taken within 6 feet of the ground's surface exceeded background levels.

Several radionuclides were detected in concentrations exceeding background in samples of surficial materials. With the exceptions of plutonium-239/240, radium-226, strontium-89/90, and uranium-235, all concentrations of radionuclides were less than the maximum background concentration for alluvium. The concentrations of uranium-233/234 and uranium-238 in the sample of bedrock from this location exceeded the upper tolerance limits for these radionuclides but did not exceed the maximum background concentrations for bedrock.

Based on the available data for borehole samples from Wells P114889 and P115489, the contaminants expected to have resulted from the burning of magnesium and lithium have not been detected in surficial materials or bedrock from these locations in concentrations that would indicate impact from this IHSS. It is possible that the low concentrations of acetone and toluene in samples from Well P115489 could be attributable to the solvents that reportedly coated the lithium burned in this area. These compounds, however, are used in a variety of analytical laboratory process and could be an artifact of laboratory contamination. It should also be recognized that these wells were not installed for the purpose of monitoring possible releases from this IHSS and are not ideally located for such a purpose.

The surface drainages have changed significantly over time. Prior to 1969 and the construction of Sage Avenue, the major surface water feature was the tributary to North Walnut Creek. Pond A-1 has been located on North Walnut Creek since January 1954. Since 1961, emission spectrographic analyses have been made on monthly composite water samples from Ponds A-1, B-4, and C-1 for the monitoring of lithium. The results of the composite sample were all less than 5 ppm lithium with most concentrations less than the minimum detection limit (Unknown, 1973). Magnesium concentrations in the surface water have not been obtained and it is not known if such information exists. Other than small quantities of magnesium being associated with the solvent burning events, there are no other known sources of magnesium or lithium in this area of the RFP that would have impacted surface water.

This IHSS is located in the North Walnut Creek drainage basin. The surface-water runoff from this site is collected in a sump located on the south side of Sage Avenue. A culvert conveys the runoff north under Sage Avenue, where a man made ditch carries the runoff east to the natural drainageway. This natural drainageway, which is the unnamed tributary to North Walnut Creek, flows north through the Protected Area.

The closest surface water monitoring site along this drainage path is SW018, which is located approximately 1,800 feet downstream. Sediment sampling site SED010 is located next to SW018, but no data for this monitoring site was obtained from the RFEDS request. The water-quality data obtained from SW018 cannot be used to reliably interpret the impacts from this IHSS. The surface water from other IHSSs also drain to this monitoring site, making it difficult to isolate the source of any constituents found in the samples.

#### 2.2.6 Waste Spills (IHSS 148)

As discussed in Appendix A, no documentation was found to support the occurrence of releases associated with this IHSS. Little or no information is currently available that would assist in

defining the nature and extent of contamination associated with this IHSS. No evidence has been obtained that would indicate that air, soil, surface water, or groundwater sampling has been conducted in this area.

The types of materials that may have come to be located in soils under Building 123 include nitrates and other laboratory materials the exact nature of which is not currently known. The possibility of the presence of low levels of radioactive materials also exists. Information on the anticipated types and concentrations of any materials that may have been released to the soil was not found. It is possible that releases from the original PWLs under Building 123 affected groundwater. No historical groundwater monitoring wells were installed to investigate any potential releases associated with this building.

Monitoring Well 4486 is located approximately 600 feet northeast of Building 123. This well is downgradient of this IHSS, and groundwater monitoring data from this well could be used to indicate possible impact to groundwater due to releases within the IHSS. However, due to the distance between the IHSS and Well 4486, the presence of several other IHSSs or other potential sources of contamination between the tanks and the well, and the lack of data on upgradient groundwater quality, any conclusions made on the basis of this information would be tenuous. Analytical data for groundwater samples from Well 4486 are discussed in Subsection 2.2.8 for IHSS 157.1.

Drainage in the area of Building 123 is not believed to have changed significantly since the building was constructed. Drainage north of the building is toward the east, and a ditch behind the building (to the south) that also leads east. Although unlikely, it is possible that the releases from the OPWLs could have impacted the surface water ditches. No historical surface-water sampling related to these releases has been found.



This IHSS is located in the lower South Walnut Creek drainage basin. The surface-water runoff draining from this site flows north to the Central Avenue ditch, then east to Pond B-1. The closest surface-water monitoring site is SW019, which is located approximately 800 feet downstream along the Central Avenue ditch. The water-quality data obtained for SW019 cannot be used to reliably interpret the impacts from this IHSS. The surface water from other IHSSs also drains to this monitoring site, making it difficult to isolate the source of any constituents found in the samples.

#### 2.2.7 Fuel Oil Tank (IHSS 152)

Several releases of fuel oil from Tank 221 have occurred in the past and are described in Appendix A. No documentation was found of any monitoring or sampling with the purpose of determining the nature and extent of contamination that may be associated with these releases. Documentation exists that contaminated soil from one of the spills was excavated and disposed of in the onsite landfill. However, documentation that the other spills had been cleaned up was not found. It is possible that some soil contaminated with hydrocarbons remains in the area, especially within the berm around Tank 221.

Geotechnical soil borings were done at the location of Tank 224 prior to construction. Most of the soils underlying Tank 224 consist of clayey sand that may provide an effective barrier to the movement of No. 6 fuel oil through the soil column (Dow, 1973). The same soil profile is probably present under Tank 221 given the close proximity of the tanks.

Well P414189 was installed approximately 60 feet southeast of Tank 224 in 1989. No samples of surficial materials or bedrock were taken at the time this well was being drilled, and groundwater samples have not been collected from the well. The nearest downgradient sampling point from this IHSS would be Well 6186, located approximately 900 feet to the east. The analytical data for groundwater samples from this well are presented in Subsection 2.2.3 for IHSS

117.3. The analytical results for groundwater samples from this well do not indicate contamination with compounds indicative of fuel oil. It should be noted, however, that the organic analyses performed on groundwater samples from this well would not detect many of the constituents of fuel oil.

Based upon the descriptions of the spills provided in Appendix A, surface water contamination was not a problem during any of the events involving the tank. The existence of a berm around the tank also should have helped to prevent surface water contamination. Runoff from the general area of these tanks enters the Central Avenue ditch, then flows northeast to Pond B-1. This IHSS is located in the lower South Walnut Creek drainage basin.

The closest surface-water monitoring site is SW020, which is located approximately 1,400 feet downstream along the Central Avenue ditch. The water-quality data obtained for SW020 cannot be used to reliably interpret the impacts from this IHSS. The surface water from other IHSSs also drains to this monitoring site, making it difficult to isolate the source of any constituents found in the samples.

#### 2.2.8 North Area Radioactive Site (IHSS 157.1)

Releases within IHSS 157.1 involved incidents when laundry effluent contaminated primarily with beryllium and depleted uranium was discharged from Building 442. One documented release from Building 442 also involved enriched uranium. Historical information regarding the nature and extent of contamination associated with these releases is limited. On October 14, 1953, 15 soil samples were taken from drainage ditches to the west and north of Building 442. These samples were analyzed for radioactivity and the results ranged from  $1.8 \times 10^4$  to  $5.2 \times 10^5$  disintegrations per minute per kilogram of soil (dpm/kg). The isotopic content of the soils was not determined. No documentation of efforts to remediate the contaminated soils was found. On March 11, 1954, standing water in a culvert 30 feet west of the building was sampled. The

water was suspected to have come from snowmelt which had drained from contaminated soil near Building 442 (Chinn, 1954). No documentation was found which details the results of the sample analysis.

The Site Survey Annual Report for 1954 stated that soil sampling throughout that year had disclosed contamination ten times the background level in the ditches near Building 442. This report states that Buildings 441 and 442 showed consistent areas of significant contamination (Kittinger, 1955). The method of soil sampling and analysis was not identified.

The soil around Building 442 has most likely been altered considerably since the time any soil contamination might have occurred in the early years of operation of the RFP. Depleted uranium which may still be present in the soil may become airborne if disturbed. Atmospheric considerations should be considered if remedial actions could result in disturbance of the soil.

The incidents of depleted uranium contamination in the soil around Building 442 may have left residual uranium on the ground surface. The area around Building 442 has been altered since the various events that may have contributed to soil contamination. There is no longer a ditch where the west ditch described in the 1953 Site Survey Report was identified; however, there is a culvert parallel to the road which empties into the Central Avenue ditch. The Central Avenue ditch was modified and expanded in 1969. During this construction process, uranium may have come into contact with the ground surface. Uranium may have entered the groundwater as a result. However, it is thought that the soil beneath Building 442 is also contaminated from the activities that occurred inside the building. The soil beneath the building has not become contaminated in the same manner as the soil outside the building. Therefore, contamination affecting the groundwater of the area may not be a direct result of this IHSS. Concentrations of contaminants in the groundwater may be greater than the source could have produced if the source is considered only to be the contaminated soil around the building.

Well 4486 is located approximately 20 feet west of Building 442. This well is located between the west drainage ditch described in the 1953 Site Survey Report and the building. Groundwater samples from this well have been collected and analyzed since March 1989. A summary of the results of groundwater monitoring at this location is presented in Table E.14 (Appendix E). Of particular interest to the characterization of the nature and extent of contamination associated with this IHSS are the above-background concentrations of uranium-233/234 and uranium-238 detected in samples from this well. The concentrations of these isotopes have exceeded the maximum background concentrations for alluvial groundwater in all samples analyzed from 1989 to 1991 (Figure 2-42). Uranium-235 was not detected in a quantifiable concentration in any of the samples.

In addition to the presence of above-background concentrations of uranium isotopes, several VOCs and several metals have been detected in groundwater from this well in concentrations exceeding background. Concentrations of PCE have ranged from 37 µg/l in the March 20, 1989 sample to 10 µg/l in the November 8, 1991 sample. The concentration of PCE has fluctuated somewhat over time but has generally decreased (Figure 2-43). Acetone; chloroform; and 1,1,1-TCA have also been detected in groundwater from this well in one sample each. VOCs detected at levels less than the analytical detection limits include 1,1-DCA, 1,1,1-TCA, and TCE. Methylene chloride, toluene, and acetone were detected in several samples but contamination of laboratory blanks was indicated for those samples.

Several metals have been detected in groundwater samples from Well 4486 in concentrations exceeding background. The only metals that have routinely exceeded their respective maximum background concentrations in this area are calcium, magnesium, and sodium. Chromium exceeded background in the June 20, 1991 sample and mercury exceeded background in the November 8, 1991 sample. Aluminum, barium, chromium, iron, lead, and manganese exceeded background levels in unfiltered samples taken during August and November of 1991. All results for beryllium have been less than the detection limit. Bicarbonate, chloride, nitrate/nitrite, and

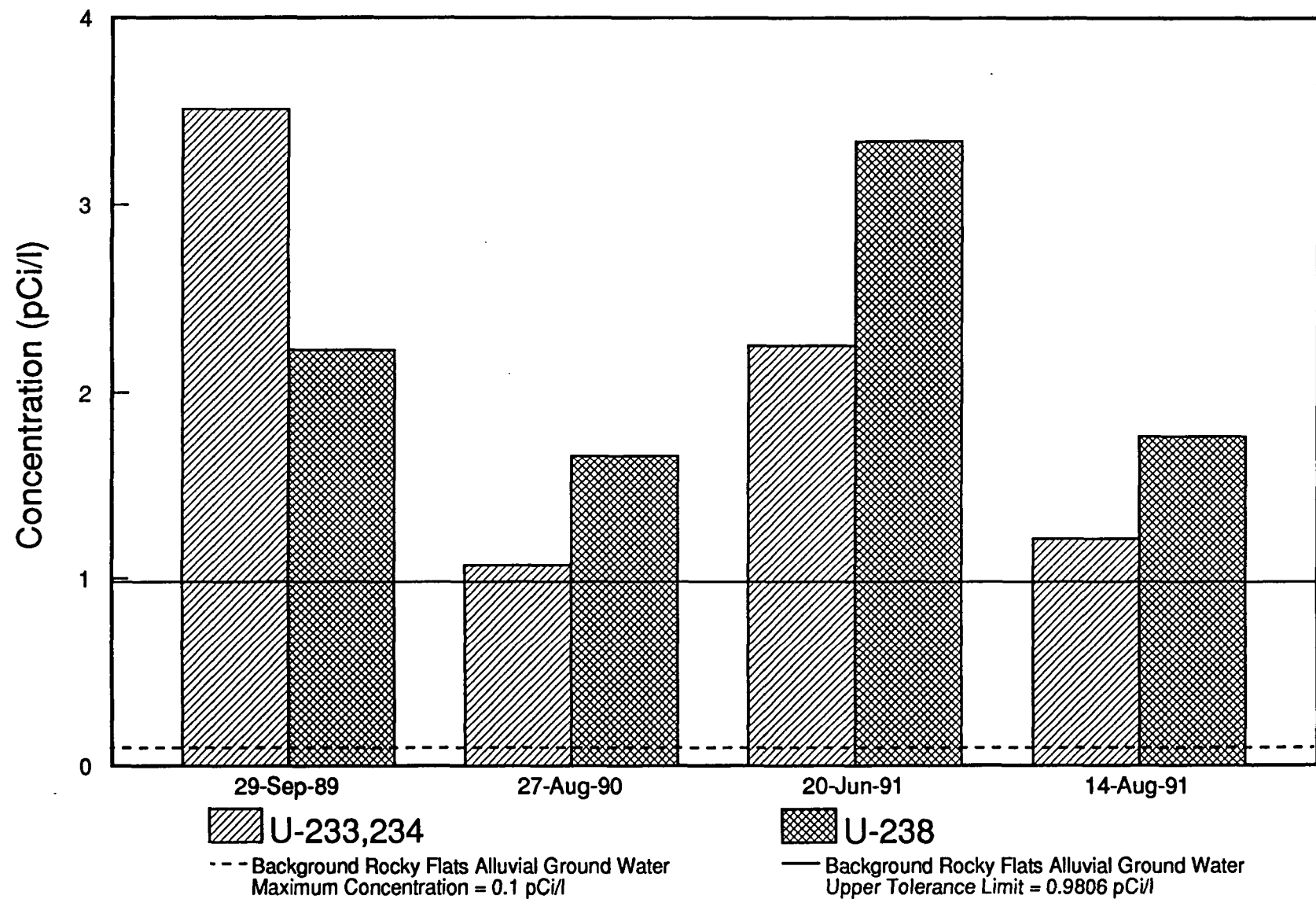


FIGURE 2-42  
 CONCENTRATIONS OF URANIUM IN GROUNDWATER SAMPLES  
 FROM WELL 4486

OPERABLE UNIT NO. 13  
 PHASE I RFI/RI WORK PLAN  
 U.S. DEPARTMENT OF ENERGY  
 Rocky Flats Plant, Golden, Colorado

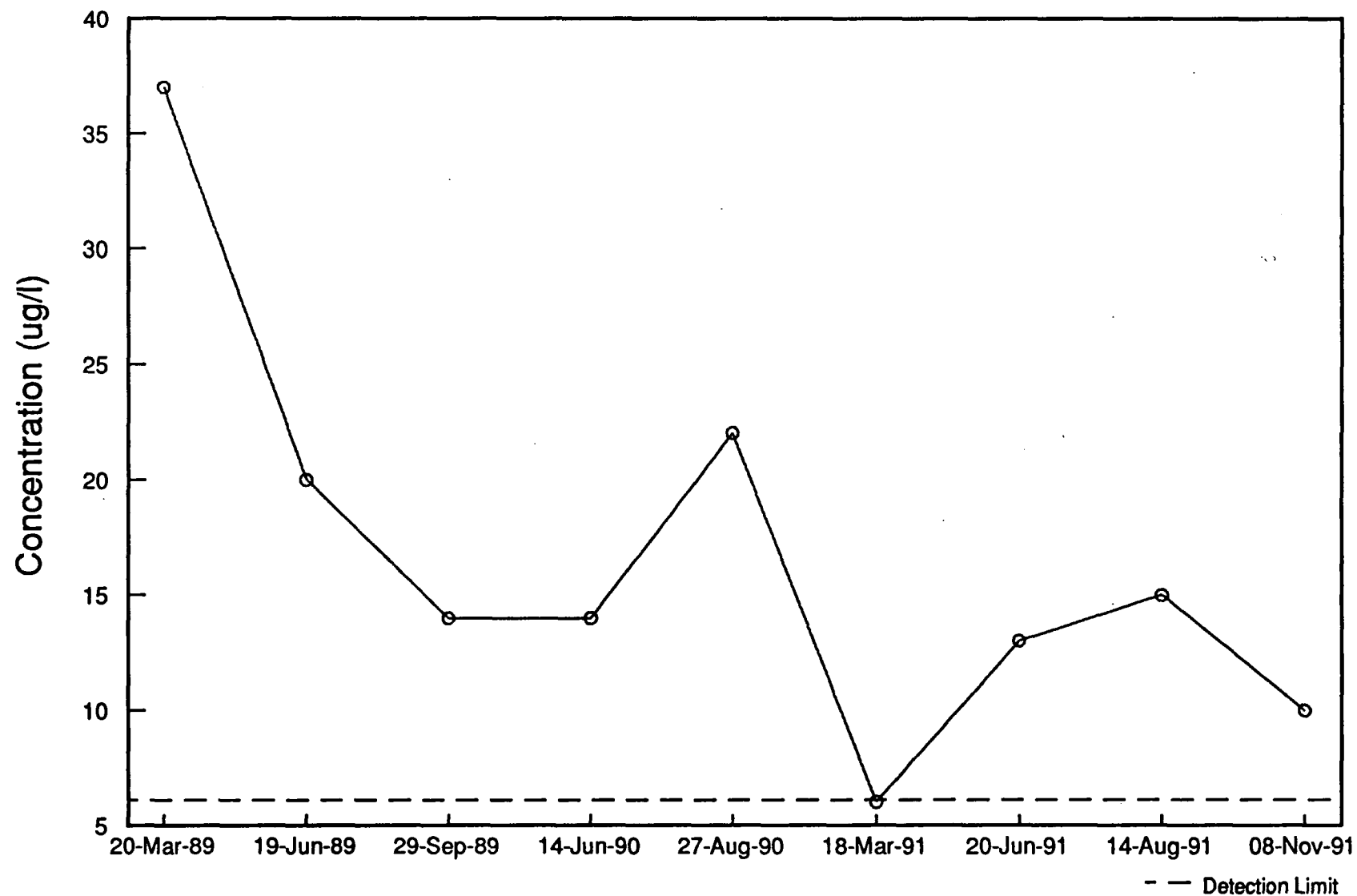


FIGURE 2-43  
CONCENTRATION OF TETRACHLOROETHENE (PCE) IN  
GROUNDWATER SAMPLES FROM WELL 4486

OPERABLE UNIT NO. 13  
PHASE I RFI/RI WORK PLAN  
U.S. DEPARTMENT OF ENERGY  
Rocky Flats Plant, Golden, Colorado

sulfate concentrations have routinely exceeded background, but concentrations of bicarbonate and sulfate were generally less than maximum background concentrations.

The analytical data for groundwater samples from Well 4486, particularly for radionuclides, indicate that groundwater in the vicinity of Building 442 may have been impacted by releases of contaminated effluent. This conclusion is preliminary, based on data of limited quantity and quality, and does not explicitly implicate this IHSS as the source of the contamination detected. Other potential sources of contamination exist in this area, and without additional information on groundwater quality upgradient and downgradient of this IHSS and information on the chemistry of surficial materials in the area, other sources of contamination cannot be eliminated.

From the 1953 account of soil sampling, contamination was detected in the soil along the drainage ditch in the direction of flow. Although the area is level and appears to have been since the construction of Building 442, the surface drainages have changed significantly. Ditches in the area carry runoff into the main Central Avenue ditch which drains into the B-Series Drainage.

This IHSS is located in the lower South Walnut Creek drainage basin. The closest surface-water monitoring site is SW019, which is located approximately 200 feet downstream along the Central Avenue ditch. The water-quality data obtained for SW019 included one sample in 1990 for gross alpha and gross beta. The average dissolved concentration for gross alpha and gross beta was 1.40 pCi/L and 6.65 pCi/L, respectively. However, these results cannot be used to reliably interpret the impacts from this IHSS. The surface water from other IHSSs also drain to this monitoring site, making it difficult to isolate the source of any constituents found in the samples.

#### 2.2.9 Building 551 Radioactive Site (IHSS 158)

As described in Appendix A, several incidents occurred in the area around Building 551 that may have resulted in releases to the environment. No documentation has been found describing

monitoring or sampling activities that have occurred and that may provide information on the nature and extent of contamination that may be associated with this IHSS. Documentation of remediation efforts in response to the incidents was not found.

Several wells were installed in the vicinity of Building 551 during 1989. Well P115589 is located near the west side of Building 551 and may provide information on conditions upgradient of the IHSS. Well P114689 is located downgradient of the IHSS, approximately 300 feet northeast of the current Building 551. Samples of surficial materials and bedrock were taken from both locations when these wells were being drilled. No samples of groundwater have been collected from either well. The available analytical data for Wells P114689 and P115589 are discussed in Subsections 2.2.1 and 2.2.2, respectively.

As discussed in Subsection 2.2.1, several VOCs were detected in surficial materials and bedrock from Well P114689. Several VOCs were also detected in concentrations less than detection limits in Well P115589. With the exception of acetone, the compounds detected in Well P114689 are different than those detected in Well P115589. Since there is no documentation of the release of organic compounds in IHSS 158, the compounds detected in borehole samples from Well P114689 may have come from another source. The concentrations of metals in borehole samples from both locations and, with the exceptions of strontium-89/90 and uranium-235, the concentrations of radionuclides detected in samples from both locations are comparable. The concentrations of strontium-89/90 and uranium-235 in samples from Well P115589 are higher than those detected in samples from Well P114689.

Based on the available analytical data and on what is currently known about the types of materials that may have been released in this IHSS, the contamination of surficial materials and bedrock in the vicinity of Well P114689 cannot be attributed to IHSS 158. Additional information on the types of releases that may have occurred within this IHSS and on other potential sources of contamination in the area are needed. Data are also needed for upgradient



and downgradient soil and groundwater conditions in order to attempt to define the source(s) of the contamination detected.

The topography is essentially flat in the area around Building 551. The ground is paved to the south and east of the building. Between Buildings 551 and 554, the ground surface slopes toward the north and is not entirely paved. Runoff flows toward the north or northeast. Flow into a ditch parallel to Sixth Street enters a culvert beneath Sage Avenue to a drainage west of Building 552. A ditch parallel to Sage Avenue directs water to the east. The area to the north of Building 552 was an empty field cut with a drainage ditch until the fall of 1986 when construction of Tanks 231A and 231B began.

This IHSS is located in both the North Walnut Creek and the upper South Walnut Creek drainage basins. The surface water draining from the west side of Building 551 flows north across Sage Avenue into the North Walnut Creek basin. The runoff draining from the north and east parts of Building 551 drains into the upper South Walnut Creek drainage basin via a manmade ditch flowing southeast and then east along the south boundary of the Protected Area.

The nearest surface-water monitoring site within the North Walnut Creek basin is SW018, located approximately 1,300 feet downstream along the unnamed tributary within the Protected Area. The nearest site within the upper South Walnut Creek basin is SW023, which is located approximately 4,300 feet downstream from Building 551.

The water-quality data obtained from surface-water monitoring sites SW018 and SW023 cannot be used to reliably interpret the impacts from this IHSS. There are other IHSSs which also drain to these monitoring sites, making it difficult to isolate the source of any contaminant.

#### 2.2.10 Waste Peroxide Drum Burial (IHSS 169)

This event is discussed in Section 2.1.1.10. It probably did not occur. If it did occur, no chemical effect would persist to the present.

#### 2.2.11 Solvent Burning Ground (IHSS 171)

The operations and potential releases from the solvent burning ground located near Building 335 are described in Subsection 2.1.1.11. This area is located adjacent to oil burn pit No. 1 (IHSS 128) and a portion of the lithium/magnesium destruction site (IHSS 134). No sampling, monitoring, or remediation activities have occurred at this site. Analytical data for borehole samples from Well P114889 located approximately 100 feet north-northeast of this IHSS are presented in Subsection 2.2.5 for IHSS 128.

Atmospheric releases at this IHSS would be limited to the combustion products of diesel fuel, gasoline, propane, or solvents. These releases have occurred approximately once a month since 1969. It is unknown if volatiles from soil contamination are currently being released into the air. However, further remediation efforts should take into consideration the possibility of potential contamination becoming airborne if the soil is disturbed.

An area due east of Building 335, extending roughly 40 feet east of the building, 20 feet north, and 50 feet south, has been the site of extensive fire training which may have resulted in the release of contaminants to the soil. The lateral extent of possible surface contamination is likely constrained by the surface drainage ditch to the south and the roadway to the east. Building 335 marks the western edge of the suspect area, although a small area near the southeast corner of the building might also have been used for small fires. The southern extent of the area used for practice fires is not clearly defined and may be anywhere from 30 to 50 feet south of Building 335 and in the vicinity of the 5-foot rise in topography (Dienst, 1992). The vertical extent of

possible contamination has yet to be determined and likely varies across the site. The fire practice area has at least four inches of gravel on the surface and has been built up over the years with other gravel layers. The depth of the porous gravel layers and the depth to groundwater are unknown and would be required for further remediation considerations.

The analytical data available for borehole samples from Well P114889 do not indicate contamination that could be attributed to this IHSS. Organic constituents expected to be associated with the wide variety of petroleum hydrocarbons and solvents reportedly burned at this site were not detected in borehole samples from this location.

Surface water from the site flows to the north into the storm drainage on the south side of Sage Avenue. A culvert conveys the runoff north under Sage Avenue, where a manmade ditch carries the runoff east to the natural drainageway. This natural drainageway, which is the unnamed tributary to North Walnut Creek, flows north through the Protected Area. The fire training involved great volumes of water, most of which flowed immediately into this drainage and likely carried uncombusted solvents away from the site. The area around Building 335 has been known to flood as it lies in a low spot near the culvert which runs under Sage Avenue (Dienst, 1992). It is unknown if any of the solvents are leaching from the soil to the surface water.

The closest surface-water monitoring site along this drainage path is SW018, which is located approximately 1,800 feet downstream. Sediment sampling site SED010 is located next to SW018, but no data for this monitoring site was obtained from the RFEDS request. The water-quality data obtained from SW018 cannot be used to reliably interpret the impacts from this IHSS. The surface water from other IHSSs also drains to this monitoring site, making it difficult to isolate the source of any constituents found in the samples.

## 2.2.12 Valve Vault (IHSS 186)

Three documented leaks of process waste have occurred in Valve Vault 12. The first incident occurred in 1986 and resulted in a release of material to the environment. The second incident occurred in 1988, and it is believed that this leak was contained in the valve vault and, therefore, there was no release to the environment. No confirmed release of material to the environment occurred as a result of the third incident, which occurred in 1989.

At the time the 1986 leak was discovered, samples of soil and water from the area around the leak were sampled and analyzed for radioactivity. Analyses of water samples from the area of the leak detected gross alpha activities of  $1.0 \times 10^3$  to  $1.7 \times 10^5$  pCi/l, gross beta activities of  $5.0 \times 10^2$  to  $5.0 \times 10^4$  pCi/l, and uranium-238 activities of  $1.0 \times 10^4$  to  $9.0 \times 10^4$  pCi/l. Americium-241 was also detected in a water sample in activities of  $3.3 \times 10^2$  and  $2.4 \times 10^2$  pCi/l. Analyses of "mud" from the area detected a gross alpha activity of  $2.0 \times 10^3$  pCi/l, a gross beta activity of  $5.0 \times 10^2$  pCi/l and a uranium-238 activity of  $1.0 \times 10^3$  pCi/l. Plutonium was not detected in samples of either water or soil. It was also reported that the analysis of soil from the contaminated area indicated no detectable amounts of hazardous wastes. Documentation of such analyses was not found. Chloride and sulfate were detected (Illsley, 1986a).

In response to the 1986 incident, up to 24 boxes of uranium-contaminated sand and gravel were excavated from the area and shipped offsite. Soil samples were reportedly collected at the time to verify contamination removal; however, the results of the analysis of these samples was not found. Due to the large area that was initially impacted and uncertainty over the extent of the leak, it is possible that soil contamination still exists. The condition of the soil used to backfill the excavation is also unknown.

It is improbable that these three incidents had an impact on the air. No documentation regarding air monitoring at the time of either incident was found. It is possible that soil disturbance during

investigative or remedial activities could cause radionuclide contaminated soil to become airborne.

Shortly after the 1986 incident, it was recommended by a member of Environmental Analysis and Control that three or four monitoring wells be installed (Illsley, 1986). Well P114789 was installed approximately 50 feet south-southwest of Valve Vault 12 in 1989. This well was installed as part of a geologic characterization program and was not installed for the purpose of monitoring releases from this or any other IHSS. Borehole samples of surficial materials and bedrock were obtained during drilling. No groundwater samples have been taken at this location. There are no soil or groundwater sampling points downgradient of this IHSS. It is also possible that the groundwater flow system in the area has been affected by the construction of Tanks 231A and 231B northeast of this IHSS. Disturbance to surficial materials during construction as well as the presence of the tanks and the containing wall surrounding them may locally affect groundwater flow.

The available analytical data for borehole samples from Well P114789 are presented in Subsection 2.2.1 for IHSS 117.1. This well is located upgradient of Valve Vault 12. This may have prevented liquid from leaks at the valve vault from impacting the soils and groundwater in the vicinity of this well. Radionuclides that were detected in concentrations greater than background in samples of surficial materials from this well were plutonium-239/240, radium-226, strontium-89/90, uranium-233/234, uranium-235, and uranium-238. The concentrations of plutonium-239/240, radium-226, strontium-89/90, and uranium-235 were greater than the maximum background concentration for alluvium in a few samples. Uranium-235 was detected in a concentration greater than the upper tolerance limit but less than the maximum background concentration in the one sample of bedrock analyzed.

Several VOCs were detected at levels less than the analytical detection limits in several samples from this well, but none were detected at concentrations exceeding the detection limits. Several

metals were also detected in concentrations exceeding background, but only the concentration of copper in one sample of bedrock was greater than the maximum background concentration.

The available analytical data for borehole samples from Well P114789 do not indicate that the releases from this IHSS have impacted surficial materials or bedrock at this location. If residual contamination is present in soils in the vicinity of this IHSS and if groundwater has been impacted by the releases, it is likely that such contamination would only be detected in wells and borings downgradient of the IHSS. At the present time, there are no wells located in the downgradient direction.

The two ditches dissecting the area may have been affected by the 1986 release. No documentation was found which elaborated on this issue. After the leak in 1986 was discovered, surface water and groundwater seeps in the area were collected in small coffer dams. The contained water was then transported to Solar Pond 207A by tank truck (Ilsley, 1987). One RFP employee who was present at the time of this leak indicated that it was unlikely that the material released had impacted surface water (Frybeck, 1992).

This IHSS is located in the North Walnut Creek drainage basin. The surface-water runoff draining from the area around this site flows north through the Protected Area in the unnamed tributary to North Walnut Creek.

The closest surface-water monitoring site along this drainage path is SW018, which is located approximately 1,300 feet downstream within the Protected Area. Sediment sampling site SED010 is located next to SW018, but no data for this monitoring site was obtained from the RFEDS request. The water-quality data obtained from SW018 cannot be used to reliably interpret the impacts from this IHSS. The surface water from other IHSSs also drains to this monitoring site, making it difficult to isolate the source of any constituents found in the samples.

## 2.2.13 Caustic Leak (IHSS 190)

Subsection 2.1.1.13 describes two leaks of sodium hydroxide from an aboveground, steel, 3,000-gallon storage tank near the southeast corner of Building 443. The first incident occurred in December 1978 and resulted in a release of sodium hydroxide to the environment. The other incident occurred on January 6, 1989. All of the sodium hydroxide from this leak was contained in the tank's secondary containment, and no release to the environment resulted.

In response to the release during the 1978 incident, alum was spread along the Central Avenue ditch to neutralize the sodium hydroxide in the ditch. In addition, alum was added to Pond B-1 to neutralize the sodium hydroxide that had reached that location. Other than monitoring the pH of water in drainage ditches, ponds, and monitoring wells east of the perimeter road, documentation of monitoring or sampling activities at the time of the leak was not found. No documentation was found of remedial actions taken in response to this leak, such as excavation of soils.

It is improbable that either documented incident resulted in an impact to air. It also does not seem likely that any residual impact to soil or groundwater in the area would be detected. The sodium hydroxide that leaked during both incidents was a raw product and, therefore, would not have contained radionuclides, metals, or other dissolved constituents. Constituents expected to be present in soils or groundwater in excessive concentrations as a result of the 1978 incident include sodium, aluminum, and sulfate. Sodium concentrations in groundwater samples from Well 4486, located approximately 150 feet northeast of the storage tank and near the drainage ditches, have routinely exceeded background. Aluminum and sulfate concentrations in groundwater from this well have generally been less than upper tolerance limits or less than maximum background concentrations. These are all naturally occurring constituents and the presence of these constituents in soils or groundwater would not necessarily indicate impacts that resulted from this incident.

It is possible that the drastic change in pH of the water in the drainage ditches that occurred after this leak may have temporarily mobilized other constituents in the sediments and soils in those ditches, but the effects of this mobilization would have been short lived. Groundwater in wells adjacent to the Central Avenue ditch east of the perimeter road was monitored after the 1978 leak. The results were considered to be normal and the groundwater in the wells did not appear to be impacted by the event.

The liquid released in 1978 flowed down the Central Avenue ditch and into Drainage Pond B-1. There was no lateral dispersion of caustic from the ditch (Frazee, 1978). Surface runoff was diverted from Central Avenue ditch and the remaining contaminated water in the ditch was contained. Impacted surface water held in Pond B-1 was neutralized and pumped to Solar Pond 207B-North. The water was then transferred to Ponds A-2 and B-2 and was subsequently sprayed on the hill adjacent to Pond B-1. Water from the spill which was being contained in Central Avenue ditch was neutralized, and, when found to be environmentally acceptable, released from the ditch. The released water probably entered Walnut Creek through the normal path through Pond B-3 and Pond B-4. Although the spills impacted the surface water at the time of the 1978 incident, it is improbable that effects of this spill are evident in the existing surface water.

The closest surface-water monitoring site along this drainage path is SW019, which is located approximately 400 feet downstream along the Central Avenue ditch. Additional sites along the flow path to Pond B-1 are SW020, SW022, and SW023, located downstream of the source of the spill approximately 1200 feet, 4500 feet, and 5100 feet, respectively. The water-quality data obtained from these sites cannot be used to reliably interpret the impacts from this IHSS. The surface water from other IHSSs also drains to these monitoring sites, making it difficult to isolate the source of any constituents found in the samples.



#### 2.2.14 Hydrogen Peroxide Spill (IHSS 191)

An incident involving the release of hydrogen peroxide from a 55-gallon drum near the intersection of Fifth Street and Central Avenue occurring during April 1981 is described in Section 2.1.1.5. No chemical effect would persist to the present.

#### 2.2.15 Summary of Surficial Material, Bedrock, and Groundwater Contamination and Additional Data Requirements

This subsection summarizes the information provided in the previous subsections on possible impacts to surficial material, bedrock and groundwater resulting from each OU13 IHSS. In addition, this subsection summarizes the data required to determine the nature and extent of contamination of surficial materials, bedrock, and groundwater attributable to each IHSS.

The data provided in the previous subsections indicate that surficial materials, bedrock, and groundwater in and adjacent to OU13 have been impacted by the RFP operations. However, the data that are currently available are not of sufficient quantity or quality to allow a determination of the nature and extent of contamination attributable to these IHSSs. Conclusions cannot be formed based on the existing data because the nature of the materials that may have been released within each IHSS are not accurately known. With few exceptions, the contamination detected in borehole and groundwater samples from the nearest well(s) to each IHSS is not indicative of the types of materials believed to have been stored, disposed, leaked, or otherwise released within that IHSS. The determination of impacts that may be attributable to each OU13 IHSS is further complicated by the presence of IHSSs to be investigated under other OU investigations and other potential sources of contamination in close proximity to or upgradient from many of the OU13 IHSSs. Both of these items point to the need for further characterization of all possible sources of contamination.

Figures 2-44 through 2-52 illustrate the available current information on contamination in the OU13 area. These figures show constituents known to be present above background levels and the locations where they have been found. The absence of a constituent at a location may indicate that it was (1) found at a concentration below background levels or (2) that it was not analyzed for. Sufficient data is not available for meaningful contouring of concentrations.

## 2.2.16 Summary of Surface-Water and Sediment Contamination and Additional Data Requirements

### 2.2.16.1 Introduction

The purpose of this section is to summarize probable surface-water impacts and data requirements associated with the RFI/RI efforts. To the extent possible, reference is made to available relevant data and information sources (see Section 6.0).

### 2.2.16.2 Approaches

Available sediment-chemistry and water-quality data from RFEDS were retrieved for inclusion in this Work Plan for the following general categories of variables:

- Radionuclides;
- Trace metals (including major cations and silicon);
- Priority pollutants; and
- Pesticides, major anions, and miscellaneous chemical constituents.

The following sampling sites were included in the RFEDS data retrieval (EG&G, 1992b):

- SW018
- SW023 (GS10)
- SW019
- SW118

- |         |          |
|---------|----------|
| • SW020 | • SED118 |
| • SW022 | • SW093  |

All surface-water monitoring sites used in this evaluation are indicated in Figure 2-53. Although available relevant data for sites SED010 and GS13 (SW092) were requested, no data were included in the RFEDS retrieval. When applicable, selective comparisons were made with geochemical-characterization results reported in EG&G documents (EG&G,1990d; EG&G 1991h). Because contaminants possibly have entered the groundwater underlying OU13, selective monitoring-well data also were evaluated, to the extent data results were available in documents.

For purposes of this assessment, available data were compared, as appropriate, with EPA's drinking-water standards (ASI, 1991e; Appendix F), the Colorado Department of Health's (CDH's) Water Quality Control Commission (WQCC) stream standards (ASI, 1991e; Appendix F), or the proposed groundwater concentration limits (EG&G, 1991d; Table 3.2). Available historical water-quality data were taken into consideration when available (ASI, 1991e; EG&G, 1990d; EG&G 1991h; and Rockwell 1989a; Rockwell 1989b; for example); otherwise, the RFEDS retrieval results of recent data for a broader aerial coverage were used (EG&G, 1992c). In addition, the applicable Federal and State of Colorado ARARs and the RFP surface-water background concentrations were used for comparison (EG&G, 1990c).

#### 2.2.16.3 Results

Available surface-water, water-quality, and sediment-chemistry data judged applicable to characterizing OU13 conditions cannot be segregated completely from other OUs. Locations of surface-water monitoring sites are such that impacts of IHSSs associated with other OUs may affect noted characteristics as documented by water-quality and sediment-chemistry data at these sites.

### Surface Water

Gross-alpha and gross-beta data were used in this assessment as indicators of radionuclides. Based upon EG&G (EG&G 1990d; Table 3.7), the reported ARARs and CDH-WQCC stream standards for total gross-alpha and total gross-beta concentrations are 7 pCi/L and 5 pCi/L, respectively. However, it was noted that these stream standards apply only to Woman Creek; the comparable stream standards for Walnut Creek are 11 pCi/L and 9 Pci/L for total gross-alpha and total gross-beta concentrations, respectively (ASI, 1991e). In comparison, the reported background limits for these two indicator radionuclides in surface water are 177 and 163 (rounded) Pci/L for total gross-alpha and total gross-beta concentrations, respectively (EG&G, 1990d, Table 3.7). Data also are available at a reduced measurement frequency for the following radioisotopes: americium-241, cesium-137, plutonium-239/240, radium-226, radium-228, strontium-89/90, tritium, uranium-233/234, uranium-235 and uranium-238 (EG&G, 1992c). No statistical analyses of the available specific radioisotopic data were included in this assessment.

For comparison, the observed indicator-radionuclide data (gross alpha and gross beta) for 9 of the 10 surface-water sites are summarized in Table 2.8. For the North Walnut Creek basin, site SW118 (and SED118, see below) is located on North Walnut Creek generally upstream from OU13-related effects as reflected by conditions monitored by site SW018, and site SW93 is located downstream from OU13 on North Walnut Creek as well as other areas potentially contributing to radionuclide sources. Gross-alpha and gross-beta concentrations at upstream site SW118 provide a characterization of pre-OU13 impacted flows: average dissolved concentrations of 2.66 and 4.75 pCi/L, respectively (for gross alpha and gross beta), and average total concentrations of 32.41 and 39.02 Pci/L, respectively. In contrast, the dissolved gross-alpha and gross-beta concentrations at downstream site SW093 are 4.70 and 5.07 Pci/L, reflecting the contributing intervening OU13-related flows characterized by site SW018 (4.81 and 8.95 Pci/L, respectively). The number of data values in the RFEDS retrieval (EG&G, 1992b) for dissolved concentrations was quite limited (two samples), and no samples at this site had reported values

Table 2.8

## Summary of Indicator-Radionuclide Data

Surface Water Site Description	Species	Gross Alpha (pCi/L)	Gross Beta (pCi/L)	No. of Samples
SW018	Dissolved	4.81	8.95	2
SW019	Dissolved	4.10	6.65	1
SW020	Dissolved	1.57	6.32	1
SW022	Dissolved	10.59	14.42	6
SW022	Total	16.41	27.33	5
SW022 Ppt <sup>1)</sup>	Total	1.18	3.25	3
SW023	Dissolved	5.41	5.70	7
SW023	Total	8.86	18.80	10
SW093	Dissolved	6.77	8.85	6
SW093	Total	19.29	23.96	15
SW118	Dissolved	2.66	4.75	7
SW118	Total	32.41	39.02	8
SW118 Ppt <sup>1)</sup>	Total	0.27	2.91	4
1) Bulk				
Sediment Samples		(pCi/Kg)	(pCi/Kg)	
SED118	Dissolved	7.62	24.81	3

for total concentrations. At any rate, average total indicator-radionuclide concentrations at the downstream site SW093 were about 2/3 of those average values reported upstream (19.29 and 23.96 pCi/L) for gross alpha and gross beta, respectively.

For the lower South Walnut Creek basin (sites SW019, SW020, and SW022) and upper South Walnut Creek (site SW023), the available RFEDS data (EG&G, 1992b) provide ambient characterization of the central and eastern parts of OU13 (Figure 2-52). For the western part of this subarea, limited data at sites SW019 and SW020 (1 sample each) provide a preliminary depiction of conditions (in terms of dissolved concentrations): 1.40 and 1.57 pCi/L for gross alpha, and 6.65 and 6.32 pCi/L for gross beta, respectively. At site SW022 downstream, average dissolved gross-alpha concentrations increase about 7-fold, and dissolved gross-beta concentrations double compared to conditions upstream sites SW019 and SW020 (with limited data), at 10.59 pCi/L and 14.42 pCi/L, respectively. Upstream data for the Central Avenue drainage ditch on total concentrations were not available (EG&G, 1992b); however, average total gross-alpha and gross-beta concentrations at site SW022 were 16.41 and 27.33 pCi/L, respectively, which is about the same levels that were noted for site SW092 on North Walnut Creek. Much of this average increase in indicator-radionuclide concentrations at site SW022 may be influenced in large part by runoff flows into the Central Avenue drainage ditch from the 903 and 904 Pad areas (Rockwell, 1989b). Flows at site SW023 are affected by flows from site SW022 at times when the Central Avenue drainage ditch is diverted northward into South Walnut Creek (Figure 2-53). Average concentrations at this site are as follows, based upon the RFEDS data (EG&G, 1992b): dissolved gross-alpha and gross-beta concentrations, 5.41 and 5.70 Pci/L, respectively; total gross-alpha and gross-beta concentrations, 8.86 and 18.80 Pci/L (Table 2.8).

Regarding trace metals (including major cations and silicon), analyses were made relatively frequently for up to 24 trace metals, the four major cations (calcium, magnesium, potassium, and sodium), and relatively infrequently for silicon. The resultant site-sample coverage is summarized in Table 2.9, based upon the RFEDS retrieval (EG&G, 1992b). Analyses for a total

Table 2.9  
Trace-Metal Sample Coverage

Site	No.	1990 Survey Dates	No.	1991 Survey Dates
SW018	0		7	3/25, 4/16, 5/30, 6/17, 8/19, 9/9, 10/7 (dissolved only)
SW019	0		1	4/12/91
SW020	0		1	4/12/91
SW022	4	7/23 <sup>3)</sup> , 9/7 <sup>2)</sup> , 11/7 <sup>2)</sup> , 11/18 <sup>2)</sup>	5	5/17 <sup>2)</sup> , 5/23 <sup>2)</sup> , 6/3 <sup>2)</sup> , 6/11 <sup>2)</sup> , 8/19 <sup>2)</sup>
SW023	6	10/16 <sup>3)</sup> , 11/16 <sup>3)</sup> , 7/23 <sup>3)</sup> , 7/24 <sup>2)</sup> , 11/8 <sup>2)</sup> , 11/19 <sup>2)</sup>	17	4/17 <sup>3)</sup> , 9/16 <sup>3)</sup> , 1/14 <sup>3)</sup> , 3/27 <sup>3)</sup> , 5/20 <sup>3)</sup> , 8/6 <sup>3)</sup> , 9/16 <sup>3)</sup> , 10/15 <sup>3)</sup> , 2/22 <sup>2)</sup> , 4/10 <sup>2)</sup> , 4/15 <sup>2)</sup> , 5/17 <sup>2)</sup> , 5/23 <sup>2)</sup> , 5/28 <sup>2)</sup> , 4/17 <sup>3)</sup> , 9/16 <sup>3)</sup> , 4/8 <sup>3)</sup>
SW093	15	7/30 <sup>3)</sup> , 6/22 <sup>3)</sup> , 7/30 <sup>3)</sup> , 8/30 <sup>3)</sup> , 9/25 <sup>3)</sup> , 10/17 <sup>3)</sup> , 11/19 <sup>3)</sup> , 1/29 <sup>3)</sup> , 2/21 <sup>3)</sup> , 3/16 <sup>3)</sup> , 5/29 <sup>3)</sup> , 7/23 <sup>3)</sup> , 7/24 <sup>2)</sup> , 9/6 <sup>2)</sup> , 10/24 <sup>2)</sup>	8	4/15 <sup>3)</sup> , 5/22 <sup>3)</sup> , 8/14 <sup>1)</sup> , 9/19 <sup>3)</sup> , 5/17 <sup>2)</sup> , 6/11 <sup>2)</sup> , 7/29 <sup>2)</sup> , 8/19 <sup>2)</sup>
SW118	2	10/29 <sup>3)</sup> , 11/23 <sup>3)</sup>	8	3/21 <sup>3)</sup> , 4/10 <sup>3)</sup> , 9/9 <sup>3)</sup> , 8/7 <sup>1)</sup> , 5/17 <sup>2)</sup> , 5/23 <sup>2)</sup> , 6/3 <sup>2)</sup> , 6/11 <sup>2)</sup>
SED118	2	9/18/90, 11/28/90	3	3/27/91, 5/21/91, 8/13/91

- 1) Dissolved
- 2) Total
- 3) Both Dissolved and Total

of 89 samples at nine surface-water sites were available for this assessment. The number of samples for a given site varied considerably, ranging from 1 sample each at sites SW019 and SW020 up to 22 and 23 samples at sites SW022 and SW093, respectively. For several samples, either only dissolved or total trace-metal concentrations were analyzed; however, for most of the samples, analyses were completed for both dissolved and total concentrations. The ARARs or associated CDH-WQCC stream standards for the trace metals were used for comparison (EG&G, 1990k; Table 3.7). Whenever appropriate, comparable EPA drinking-water standards were considered (ASI, 1991e). Results of these comparisons follow.

Regarding priority pollutants (semivolatile/volatile compounds), applicable ARARs and CDH-SWCC standards for only selected chemicals in this category of constituents are reported (EG&G, 1990k; Table 3.7). A total of 20 detectible concentrations were noted in the RFEDS retrieval (EG&G, 1992c), as indicated in Table 2.10. Fifteen of these 21 detectible concentrations involved methylene chloride, with surface-water concentrations ranging between 5 and 130 ug/L and found at six of the nine sites. The possibility of laboratory contamination exists since methylene chloride and acetone was also found in the laboratory blanks. Chemical constituents found in detectible concentrations to a lesser extent were carbon tetrachloride (one sample at site SW018), chloromethane (same sample), acetone (one sample each at sites SW023 and SW118), and tetrachloroethene (1 sample at site SW093).

Regarding the category of pesticides, major anions, and other miscellaneous chemical constituents, a total of 17 surface-water samples at nine monitoring sites were each analyzed for a suite of 27 pesticide compounds. In all cases, no detectible concentrations were found (EG&G, 1992c). The associated ARARs and CDH-WQCC standards for some of these constituents are found in EG&G (EG&G, 1990d; Table 3.7); however, no background limits were specified. In the case of data on major anions or other miscellaneous constituents (such as percent moisture, pH, selected nutrient species, dissolved solids, and suspended solids associated with surface waters), no evaluation was made of values in the RFEDS retrievals, because these constituents



Table 2.10  
Summary of Primary Pollutants

Site	Date	Chemical Compound	Concentration (units)
SW118	10/29/90	Methylene chloride	6 ug/L
SW018	05/30/91	Methylene chloride	6 ug/L
	06/17/91	Carbon Tetrachloride	8 ug/L
	06/17/91	Chloramethane	130 ug/L
	06/17/91	Methylene chloride	36 ug/L
	09/09/91	Methylene chloride	9 ug/L
SW023	09/16/91	Methylene chloride	8 ug/L
	08/06/91	Acetone	15 ug/L
	08/06/91	Methylene chloride	9 ug/L
	09/16/91	Methylene chloride	7 ug/L
SW093	07/30/90	Methylene chloride	4 ug/L
	01/29/90	Methylene chloride	6 - 7 ug/L
	04/15/91	Methylene chloride	19 ug/L
	08/14/91	Methylene chloride	38 ug/L
	09/19/91	Methylene chloride	6 ug/L
	09/19/91	Tetrachloroethene	6 ug/L
SW118	10/29/90	Methylene chloride	6 ug/L
	08/07/91	Acetone	15 ug/L
	08/07/91	Methylene chloride	12 ug/L
SED118	09/18/90	Methylene chloride	10 ug/Kg
	11/28/90	2-Butanone	59 ug/Kg
	05/21/91	Methylene chloride	110 ug/Kg
	08/13/91	Acetone	21 ug/Kg
	08/13/91	Methylene chloride	23 ug/Kg

were not particularly useful in discerning sources or extent of contaminants relative to the other variables discussed above.

### Sediments

Gross-alpha and gross-beta data were used as indicators of radionuclides in sediments, as was the case discussed above for surface-water characterizations. Based upon EG&G (EG&G, 1990k; Table 3.7), no ARARs or CDH-WQCC stream standards are applicable for gross-alpha or gross-beta concentrations analyzed on stream sediments. However, the reported background limits for these two indicator radionuclides in surface water are 57.75 and 51.76 (rounded) pCi/L for gross-alpha concentrations and gross-beta concentrations, respectively (EG&G, 1990k; Table 3.7). For comparison, the observed indicator-radionuclide data for the one sediment-chemistry site SED118 are summarized in Table G.1, Appendix G. Average (based upon three samples) concentrations for dissolved gross-alpha and gross-beta concentrations were 7.62 and 24.81 pCi/L, respectively.

Data also are available at a quite limited measurement frequency for the following radioisotopes: americium-241, cesium-137, plutonium-239/240, radium-226, radium-228, strontium-89/90, tritium, uranium-233/234, uranium-235, and uranium-238. These averages are considerably below the reported background limits indicated above.

Analyses were made relatively frequently for up to 24 trace metals (including major cations and silicon), the four major cations (calcium, magnesium, potassium, and sodium), and relatively infrequently for silicon at the single sampling site SED118. The resultant statistical summary is given in Table G.1 (Appendix G), based upon the RFEDS retrieval (EG&G, 1992b). Analyses for five samples were available for this assessment. Only total trace-metal concentrations were analyzed on these sediment samples. The ARARs or associated CDH-WQCC stream standards for the trace metals were used for comparison (EG&G, 1990d; Table 3.7). Whenever appropriate,

comparable EPA drinking-water standards were considered (ASI, 1991e). Results of these comparisons follow.

Five detectible concentrations of priority pollutants (semivolatile/volatile compounds), were noted in the RFEDS retrieval (EG&G, 1992b) for the single sediment-survey site (SED118) located on North Walnut Creek, as indicated in Table 2.10. For this set of constituents, ARARs and CDH-WQCC standards are not applicable in the case of sediment chemistry; however, no background limits for selected priority pollutants were given in EG&G (EG&G, 1991d; Table 3.7). Three of these 5 detectible concentrations found in the RFEDS retrieval (EG&G, 1992b) involved methylene chloride with surface-water concentrations ranging between 10 and 110 ug/kg. Chemical constituents found in detectible concentrations to a lessor extent were 2-butanone (one sample) and acetone (one sample).

Regarding the category of pesticides, major anions, and other miscellaneous chemical constituents, a total of 5 sediment-chemistry samples at single monitoring sites were each analyzed for a suite of 27 pesticide compounds. In all cases, no detectible concentrations were found (EG&G, 1992b). No ARARs and CDH-WQCC standards for constituents are applicable in the case of sediments (EG&G, 1990d; Table 3.7) and no background limits were specified. In the case of data on major anions or other miscellaneous constituents (such as percent moisture, pH, selected nutrient species, dissolved solids, and suspended solids associated with sediments), no evaluation was made of values in the RFEDS retrievals, because these constituents were not particularly useful in discerning sources or extent of contaminants relative to the other variables discussed above.

#### 2.2.16.4 Conclusions

Selective aspects of continuing surface-water and interactive groundwater monitoring programs at the RFP will aid further in the characterization as well as assessment of identified areas of

concern regarding existing or potential contamination in the OU13 area. Subsequent data analyses should be more detailed and focus on selected chemical-constituent and ancillary hydrologic data identified with past activities in this operable unit. Such causes and possible sources have been documented in large part by delineation and descriptions of the several IHSSs in this operable unit, with the qualification of possible impacts of IHSSs and conditions in other operable units that are unrelated to OU13 impacts.

#### 2.2.17 Summary of Air Impacts and Data Requirements

Air pathway concerns associated with OU13 include volatile organic compounds, radioactive materials, and other inorganics in the form of vapors, aerosols, and contaminated particulate material. Lateral migration of these materials into surrounding soils and beneath the area of release may have resulted in additional areas of secondary contamination. Migration through soil, groundwater, and by windblown dust can serve as an effective conduit for dispersal of contaminants and sustain long-term, area-wide volatile and particulate emission sources. Volatile emissions are likely from those IHSS sites containing organic solvents or petroleum wastes, particularly if they exist in a liquid phase. Fine-textured geologic materials especially those particles possessing an aerodynamic diameter of  $40\mu$  or less and subject to mechanical disturbance or strong surface winds offer the strongest potential for furnishing contaminated airborne particulates.

All contaminated soils and liquids whether at the point of initial contamination or after migration has occurred, represent a potential source of fugitive (non-point source) air emissions. This may occur by means of molecular diffusion into the air-soil matrix and subsequent expulsion to the atmosphere, by diffusion directly to the atmosphere, or by adherence onto mobile-geologic or aqueous material. The rate of contaminant transfer to the air is site-dependent, contingent upon the size, and concentration of the contaminant, the chemical and physical properties of the spilled material, the adhesion characteristics of non-mobile matrices, and existing meteorological

conditions. Emissions may occur continuously or episodically over broad area. Sometimes the emitting surface becomes depleted of contaminant and acts as an inhibitor to further emissions. Disturbance of such barrier surfaces may enhance the rate of contaminant transfer to the air.

Particles contaminated with sorbed organics and possibly radionuclides or metals are the OU13 contaminant fractions most likely to be measurably encountered in the air. However, because of the low level of contamination associated with individual OU13 IHSSs, the amount of contaminant-laden airborne particulates attributable to OU13 Work Plan implementation is anticipated to be very small.

Nonradioactive ambient air monitoring at the RFP provides baseline information on particulate levels. The RFP monitors ambient air with both Total Suspended Particulates (TSP) and Particulate Matter 10 microns or less in diameter (PM-10) samplers. In 1988, CDH requested concurrent TSP sampling until State regulations were changed to reflect PM-10 changes in Federal regulations. The site where TSP and PM-10 samplers are located near the east entrance to the RFP. This location is unobscured by structures, near a traffic zone, and generally downwind from the RFP buildings. Samplers are operated on a schedule of one day per every sixth day.

Ambient radiological air samplers are located in the RFP site operations area, at the RFP perimeter [at distances of approximately 3 to 6 kilometers (2 to 4 miles) from the plant's center], and in surrounding communities. These RFP-designed air samplers operate continuously at a volumetric flow rate of approximately 12 l/s (25 ft<sup>3</sup>/min), collecting air particulates on 20-x 25-cm (8- x 10-in.) fiberglass media. Manufacturer's test specifications rate this filter media to be 99.97 percent efficient for the relevant particle sizes under conditions typically encountered in routine ambient air sampling (Schleicher and Schuell, 1982). Airborne particulates in ambient air have been sampled continuously at 25 locations within and adjacent to the RFP operations

area (Figure 2-54). However, two samplers (5-12 and 5-15) are temporarily inactive. The sample filters are collected biweekly from all RFP samplers.

#### 2.2.17.1 Air Quality Data Analysis

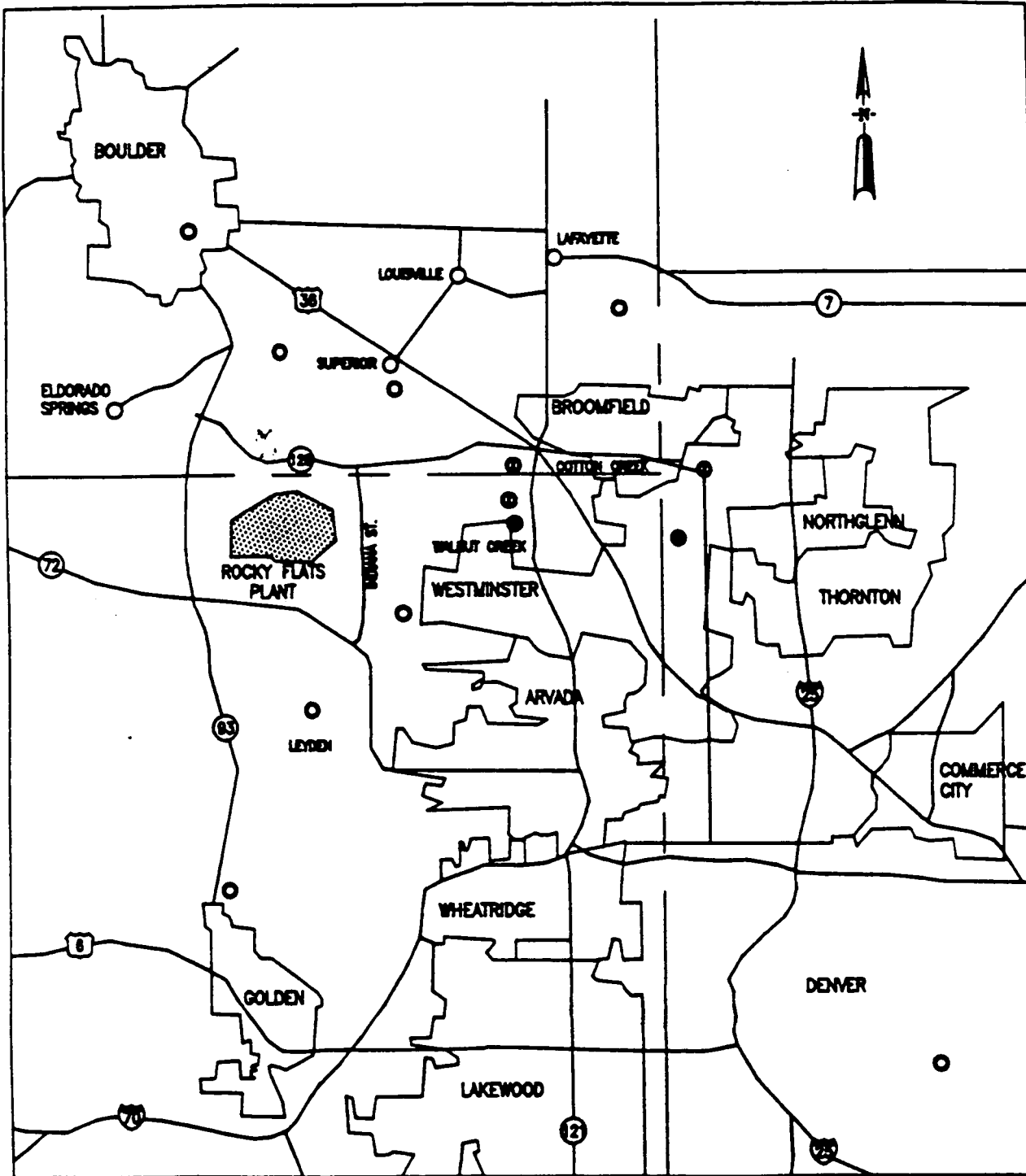
Insufficient data is available to support a summary of air quality impacts specific to OU13. However, considerable data is available for the RFP.

#### Radiological Data

During 1988, four samples exceeded the TLL- $\alpha$  screening level and were analyzed for plutonium. The mean concentrations of plutonium in ambient air at the five onsite stations during 1988 ranged from  $0.149 \times 10^{-15}$  to  $0.710 \times 10^{-15}$   $\mu\text{Ci/ml}$  ( $5.51 \times 10^6$  to  $2.63 \times 10^5 \text{ Bq/m}^3$ ). These concentrations are less than 4 percent of the offsite Derived Concentration Guide (DCG) for plutonium in air. Radioactive ambient air samplers monitor airborne dispersion of radioactive materials from the RFP into the surrounding environment. Samplers are designated in three categories by their proximity to the main facilities area. Twenty-five onsite samplers are located within the RFP, concentrated near the main facilities area. Fourteen perimeter samplers border the RFP along major highways on the north (Highway 128), east (Indiana Street), south (Highway 72), and west (Highway 93) (Figure 2-54). Thirteen community samplers are located in metropolitan areas adjacent to the RFP (Figure 2-55).

Filters were collected biweekly from all the RFP samplers and analyzed for plutonium. Each biweekly filter from the onsite samplers was analyzed separately each month except in December. Filters collected in December were composited by location into one onsite sample. Filters from perimeter and community samplers are collected biweekly, composited by location, and analyzed monthly for plutonium. Five onsite samplers (S-5 through S-9) have historically shown the highest TLL- $\alpha$  activities for the sampling network.





NOT TO SCALE

**EXPLANATION**

- OFF-SITE COMMUNITY AMBIENT AIR SAMPLES  
(ANALYZED AS MONTHLY COMPOSITES FOR  
PLUTONIUM-239/240)

U.S. DEPARTMENT OF ENERGY  
Rocky Flats Plant  
Golden Colorado

OPERABLE UNIT NO. 13  
PHASE I RFI/RI WORK PLAN

FIGURE 2-55

**LOCATION OF OFF-SITE COMMUNITY  
AMBIENT AIR SAMPLERS**



Overall mean plutonium concentration for onsite samplers was  $0.072 \times 10^{-15}$   $\mu\text{Ci/ml}$  ( $2.7 \times 10^{-6}$   $\text{Bq/m}^3$ ), 0.36 percent of the offsite DCG for plutonium in air. Overall mean plutonium concentration for perimeter samplers was  $0.003 \times 10^{-15}$   $\mu\text{Ci/ml}$  ( $1.1 \times 10^{-7}$   $\text{Bq/m}^3$ ). Overall mean plutonium concentration for community samplers was  $0.001 \times 10^{-15}$   $\mu\text{Ci/ml}$  ( $3.7 \times 10^{-8}$   $\text{Bq/m}^3$ ). These values are 0.013 percent and 0.005 percent, respectively, of the offsite Derived Concentration Guide (EG&G 1991i).

None of the air samplers in or adjacent to OU13 have shown high TLL- $\alpha$  activities. However, one recently deactivated sampling station, S-15, did exhibit elevated plutonium levels for TLL- $\alpha$  levels in 1988. Station 15 is located to the west of the operable unit and showed an increase in 1988 activity of less than four percent of the offsite Derived Concentration Guide for plutonium in air. For 1990, Table 2.11 describes on-site ambient air plutonium concentrations.

### Nonradiological Data

The highest TSP value recorded in 1990 (24-hour sample) was 134 micrograms per cubic meter ( $\mu\text{g/m}^3$ ) (51 percent of the former TSP 24-hour primary standard), and the annual geometric mean value was  $31.4 \mu\text{g/m}^3$  (12 percent of former TSP primary annual geometric mean standard). The observed 24-hour maximum for the PM-10 sampler was  $26 \mu\text{g/m}^3$  (17 percent of the primary 24-hour standard) and the annual arithmetic mean was  $9.8 \mu\text{g/m}^3$  (20 percent of the primary annual arithmetic mean standard).

#### 2.2.17.2 Use of Existing Data

The air quality and meteorological monitoring programs at the RFP have routinely monitored for meteorological parameters, total suspended particulates, and ambient air concentrations of radionuclides on particulates. These data sets combine to provide a record of the radionuclide concentrations and trends, the mode of radionuclide transportation, and a measure of the

Table 2.11

**Perimeter and Community Ambient Air  
Sampler Plutonium Concentrations**

**Perimeter Ambient Air Sampler Plutonium Concentrations**

Station	Number of Samples	Concentration ( $10^{-15}$ Ci/ml)			Standard Deviation	Percent of DCG
		C Minimum	C Maximum	C Mean	(C Standard)	(C Mean)
S-31	11	-0.001	0.002	0.001	0.001	0.003
S-32	12	0.000	0.003	0.001	0.001	0.007
S-33	12	-0.001	0.004	0.000	0.001	0.002
S-34	12	0.000	0.005	0.002	0.001	0.009
S-35	12	-0.001	0.003	0.001	0.002	0.004
S-36	12	0.000	0.003	0.001	0.001	0.005
S-37	12	0.000	0.007	0.003	0.001	0.014
S-38	12	0.000	0.181	0.017	0.002	0.083
S-39	12	10.001	0.002	0.001	0.052	0.003
S-40*	11	0.000	0.032	0.004	0.001	0.019
S-41	12	0.000	-0.003	0.001	0.009	0.005
S-41	12	0.000	0.004	0.001	0.001	0.005
S-43	12	-0.001	0.003	0.001	0.001	0.003
S-44	12	-0.001	0.004	0.001	0.001	0.003
<b>Overall</b>	<b>166</b>	<b>-0.001</b>	<b>0.181</b>	<b>0.005</b>	<b>0.005</b>	<b>0.013</b>

containment of the source, although no central report has integrated the data from the past 10 years.

Characterization of ambient air quality at OU13 will require compiling relevant existing data. The relevant existing data consists of meteorological data collected from the monitoring station at the RFP. Parameters of interest include wind speed, wind direction, sigma theta, temperature, relative humidity, and precipitation. Hourly averages of these data may be required for performance of refined air quality impact analysis. Daily summaries of the other parameters will be required and must be maintained in a form amenable for use in dispersion modeling codes.

#### 2.2.17.3 Description of Additional Data Required

##### General

Soil gas surveys are planned for select IHSSs believed to contain VOCs. This data can: (1) identify areas of higher than average soil gas contaminant content and their movements, (2) serve as model inputs (source terms) to estimate ambient air concentration under changing meteorological conditions, and (3) estimate uncontrolled emissions levels during invasive site operations. This information may be coupled with indirect monitoring data collected in accordance with the Site-Specific Health and Safety Plan to help understand the potential impacts attributable to individual IHSS sites. If contaminants are detected in the soil gas sampling specified in this Work Plan, appropriate air monitoring should be conducted as part of Stage 3 of the Field Sampling and Analysis Plan.

##### Monitoring Stations

Construction and analysis of isopleth maps of ambient concentrations require a network of stations on and around the site. There are ambient air monitoring stations of interest to this investigation. The monitors are located within the perimeter of OU13 (S-2 and S-17) and outside

the perimeter (S-12, S-13, S-14, S-16). S-16 is located to the northwest, S-14 is located to the west, S-13 is due south, S-12 (which is currently inactive) is located to the southeast, S-17 is due east, and S-2 is located northeast of OU13. With the exception of S-12, which will remain inactive for two years, these six samplers encircle the operable unit and provide a representative airborne particulate sample both upwind and downwind (according to prevailing area wind patterns). These samplers also provide data from directions not normally associated with the prevailing wind pattern. Stage 3 air sampling for OU13 may require reactivation of the S-12 monitoring site. If a need is identified for additional stations to characterize air quality impacts, the stations should be selected on the basis of the dominant wind patterns at the site, discussed in Section 1.0. Since the plumes from the site will be directed by the wind, locating monitors downwind will allow sampling of the plumes. The primary wind direction is northwesterly. If additional onsite stations are needed for Stage 3 sampling, they should be distributed to take maximum advantage of these dominant wind directions.

#### Monitored Contaminants and Analysis

If analysis of soil gas survey or radiological surveys produce estimates of ambient air concentrations that pose a health risk, an air monitoring program will be established at OU13. The recommended air monitoring program should monitor all contaminants detected in the geologic and hydrologic surveys. High-volume samplers are proposed for this application because they provide a high particulate loading on the filters. Heavily-loaded filters provide greater contaminant concentrations per unit filter area and therefore, greater detectability than lightly-loaded filters. Filters in the low-volume total suspended particulate samplers, which are used for radiological ambient sampling, are often so lightly loaded that collected radionuclides exist at concentrations which fall below detection limits. Since high-volume samplers sample almost twice as large a volume of air in 24 hours ( $2448 \text{ m}^3$ ), they should collect commensurately more contaminant mass and provide better detectability than the low-volume filters. Additionally,

EPA guidelines specify that total suspended particulates should be sampled with a high-volume sampler (EPA, 1985) for analysis of inorganic compounds.

### Sampling Schedule

If additional air monitoring stations are required, they should operate over a one year period. A full year of data is necessary to ensure that the data are collected during all conditions that occur at the RFP. A full year of data will allow accurate estimation of the maximum and mean on-site concentrations that workers are exposed to and quantification of the flux of contaminants off the site.

#### 2.2.18 Previous Investigations in the OU13 Area

Due to its location near the center of the RFP, OU13 is adjacent to, or overlaid by several other OUs, including OU2, OU6, OU8, OU9, OU10, OU12, OU14, OU15, and OU16. Three of these OUs are either currently undergoing studies or have had current studies completed that are likely to provide data supporting the determination of the nature and extent of contamination at OU13. These OUs are OU2 (903 Pad, Mound and East Trenches), OU8 (700 Area) and OU10 (Other Outside Closures). The RFI/RI Phase II Work Plan for OU2 was conditionally approved by the regulatory agencies.

In addition, several previous investigations and studies have been undertaken at OU13 in response to spills related to the IHSSs. These investigations and studies include the following:

- Environmental Release Report - Building 123 Process Waste Line Break; Sanchini, D.J., May 1989;
- Issue Statement: Update on Valve Vault No. 17 Flooding Incident Investigation; Twining, B.G., April 1989;
- Building 123 Contamination Investigation; Freehling, M.J., May 1989;

- RCRA Report - Acid Release, Goldber, E.S., June 1989;
- Valve Vault 17 Incident; Browdy, S.L., June 1989;
- Report of Investigation of Acid Leak, Building 443, September 11, 1970; Williams, A.K., E.M. Bellagamba, C.R. Rose, C.W. Ellis, C.R. Heiple, September 1970;
- No. 6 Diesel Oil Spill UE 89-152, Ortiz, J.M., February 1989;
- CEARP, Phase I Effluent Pipe, 700 Area, Unknown, April 1986; and
- Steam Plant Fuel Oil Tanks Background/Chronology/Action Plan, Setlock, G.H., March 1986.

## 2.3 SUMMARY OF IHSS CONCEPTUAL MODELS

Using the known site physical conditions and potential contamination sources described in the preceding sections, a conceptual model of exposure pathways is developed here for two IHSS groups in OU13. The conceptual models have been developed for use in the evaluation of potential risks of OU13 contamination to human health and the environment. The IHSSs were organized into the two logical groups to simplify the conceptual models. The IHSSs are categorized based source type and release mechanism.

The two groups are as follows:

Group I      Releases Originating Above Ground and Affecting Surficial Materials

Group II      Releases Originating and Affecting Transport Media Below Ground Surface

The primary purpose of a conceptual model is to aid in identifying exposure pathways by which human and biotic receptors may be exposed to contaminants. EPA defines an exposure pathway

as "...a unique mechanism by which a population may be exposed to chemicals at or originating from the site..." (EPA, 1989b).

As shown in Figure 2-56 an exposure pathway must include a contaminant source, a release mechanism, a transport medium, an exposure route, and a receptor. An exposure pathway is not complete without each of these five components. The individual components of the exposure pathway are defined as follows:

- **Contaminant Source:** For purposes of the OU13 conceptual models, the contaminant source is divided into primary sources (IHSSs) and secondary sources media that have potentially been affected by these releases). Secondary sources will be focused on since they may currently contain contaminants that can still be released to the environment.
- **Release Mechanism:** Release mechanisms are physical and/or chemical processes by which contaminants are released from the source. The conceptual model identifies mechanisms that released contaminants directly from the primary sources (i.e., leaks, spills, overflows, etc.), and mechanisms that may release contaminants from the secondary contaminant sources.
- **Transport Media:** Transport media are the environmental media into which contaminants are released from the source and are in turn released to a receptor. Potential transport media for OU13 include air, surface water, groundwater, and biota.
- **Exposure Route:** Exposure routes are avenues through which contaminants are physiologically incorporated by a receptor. Exposure routes for receptors at OU13 are inhalation, ingestion, and dermal contact.
- **Receptor:** Receptors are human or environmental populations that are affected by the contamination released from a site. Human receptors for OU13 include the RFP workers and visitors, and offsite residents. Environmental receptors are biota (both flora and fauna) indigenous to the OU13 environs.

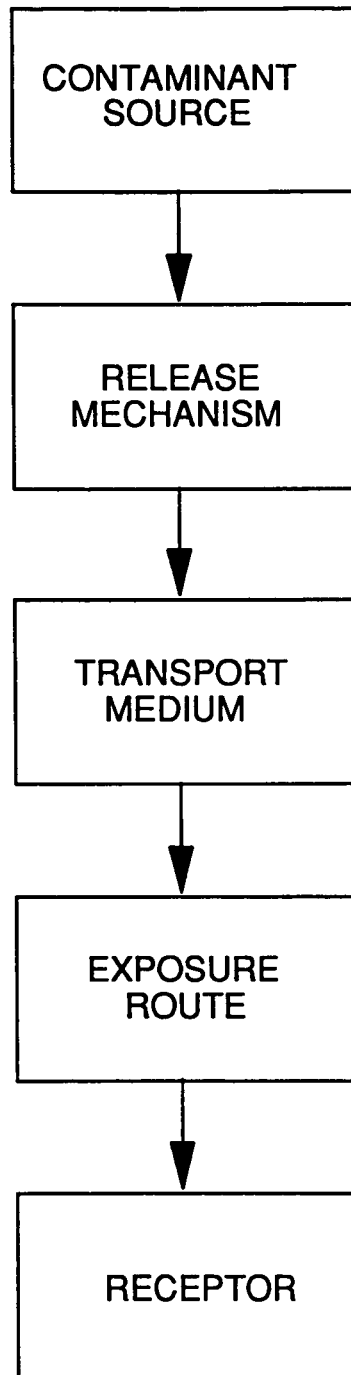


FIGURE 2-56  
COMPONENTS OF A COMPLETED  
EXPOSURE PATHWAY

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### 2.3.1 OU13 GENERALIZED CONCEPTUAL MODEL

Diagrams of the conceptual models for potential secondary contaminant sources, transport media, exposure routes, and receptors relating to the OU13 IHSSs are presented in Figures 2-57 and 2-58. The various aspects of the conceptual model are explained in the following sections.

#### 2.3.1.1 Contaminant Sources

The 15 IHSSs that constitute OU13 are located to the south and west of the Protected Area of the RFP, in the general area of the 100 series buildings.

Primary contamination sources within the various IHSSs include above-ground and underground tanks, underground pipelines, storage areas, and solvent/metal destruction sites. Contaminants from these sources may have been introduced into the environment through spills on the ground surface, underground leakage and infiltration, explosion and/or fire, and in some cases through incident precipitation run-on and run-off. Contamination may still be entering the environment from some of the sources; in other areas, the sources may be exhausted or may have been physically mitigated through remediation at the time of the initial release.

Exclusive of volatilization to the atmosphere, the contaminants first enter the environment through the soil, and are transported by various mechanisms from affected soil to unaffected media. Groundwater is another medium that, once affected, could spread contaminants to unaffected media. Therefore, for conceptual purposes, contaminated soils and groundwater are considered secondary contaminant sources in both Groups. These secondary sources will receive the most attention during Phase I RI/RFI activities since it is a probable current source. Contaminants from secondary sources could be spread to other media through secondary release mechanisms including disturbance of soil dust, volatilization and resettling of dust, surface water runoff, infiltration/percolation of water, bioconcentration/accumulation, and physical tracking.

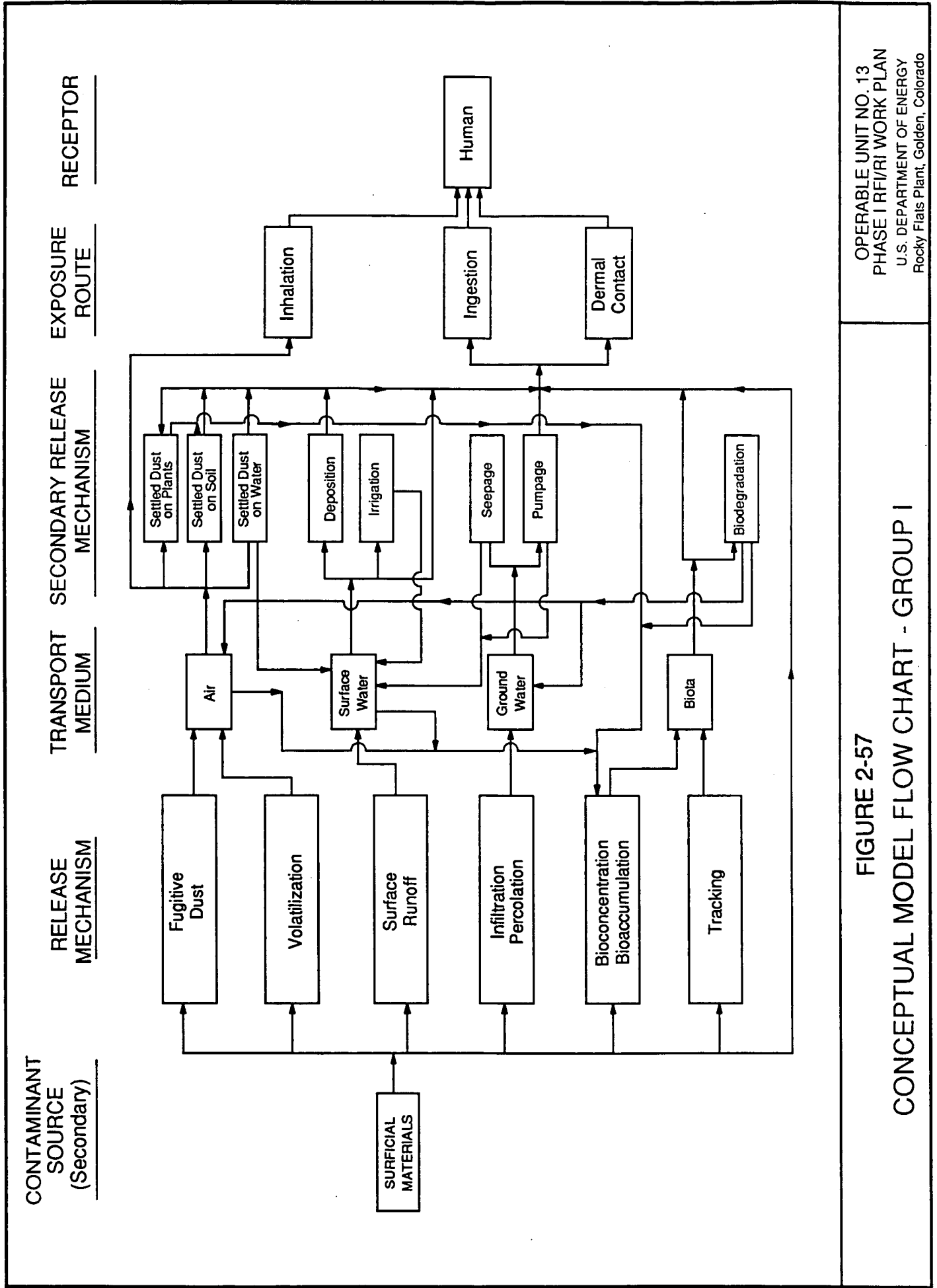


FIGURE 2-57

CONCEPTUAL MODEL FLOW CHART - GROUP I

CONTAMINANT  
SOURCE  
(Secondary)

RELEASE  
MECHANISM

TRANSPORT  
MEDIUM

SECONDARY RELEASE  
MECHANISM

EXPOSURE  
ROUTE

RECEPTOR

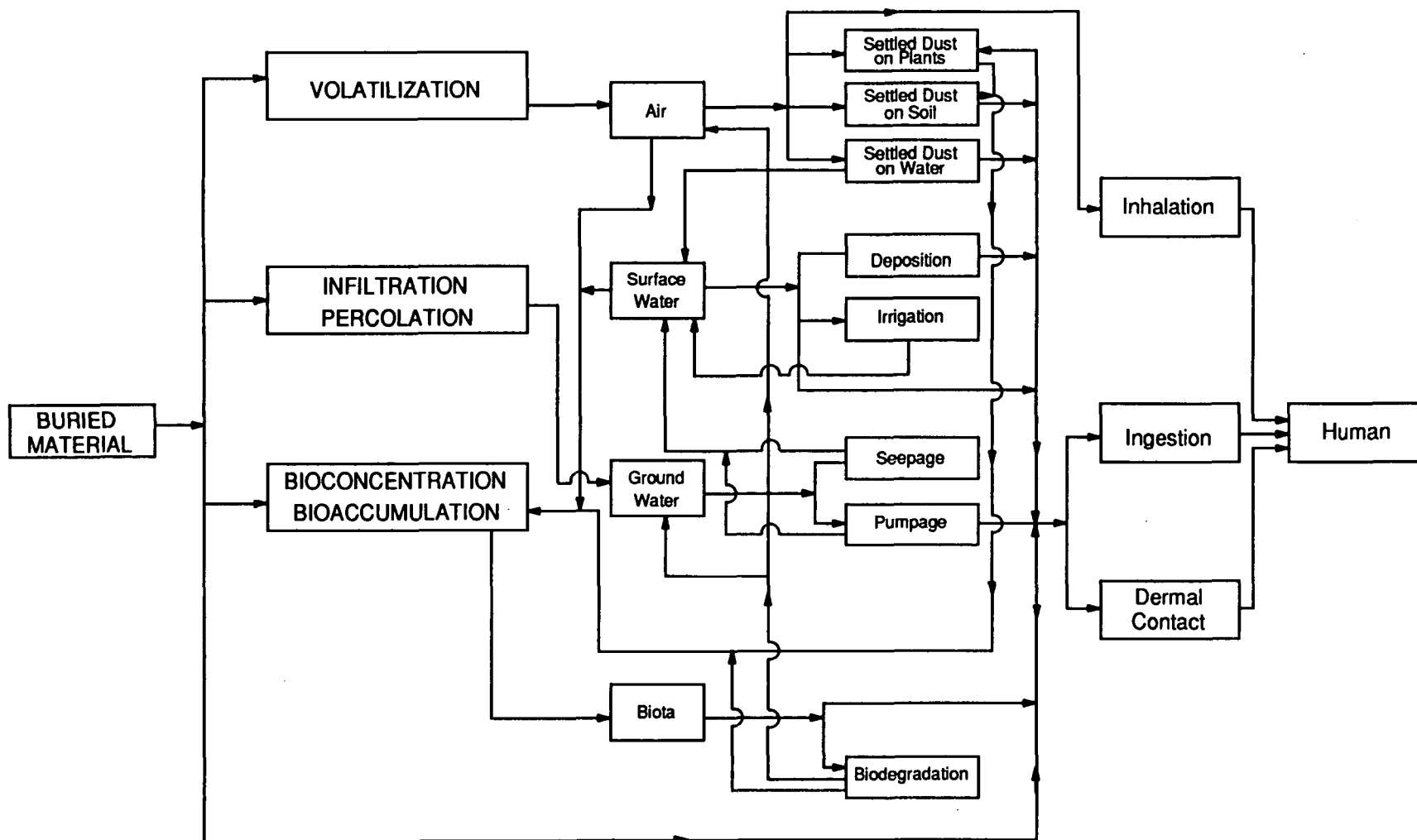


FIGURE 2-58

CONCEPTUAL MODEL FLOW CHART - GROUP II

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The chemical composition of the contaminants varies widely between the IHSSs, ranging from low-level mixed wastes to nonradioactive organic and inorganic compounds.

Most IHSSs in OU13 overlie or are immediately adjacent to other nearby IHSSs. Thus, it may not always be possible to differentiate between contamination from specific IHSSs. Therefore, the precise extent of contamination from a given IHSS may be difficult or impossible to determine.

#### 2.3.1.2 Potential Transport Mechanisms and Receptors

As mentioned above, potential transport mechanisms in OU13 include air, surface water, groundwater, and biota. Air pathways will be addressed by surface soil and soil gas characterization. The surface water pathway will be addressed by sitewide integrated surface-water sampling. The groundwater pathway will be addressed by subsurface soil and water sampling and hydrostratigraphic unit examination through the use of soil and bedrock boreholes and groundwater wells. Individual IHSS potential contaminant pathways may commingle with pathways from other IHSSs.

Potential contaminant receptors include the RFP workers and visitors, off-site residents, and terrestrial and aquatic biota. These receptors could be exposed to OU13 contaminants through ingestion, inhalation, or dermal contact (Figures 2-57 and 2-58).

#### Air

Potential movement of contaminants by wind is possible wherever contaminated soils exist. The likelihood of airborne contamination increases greatly if the site is disturbed by traffic, construction, or similar activity. Dust-borne contaminants mobilized by wind have been documented in some areas of the RFP.

Some releases involving constituents such as volatile organic compounds (VOCs), while impacting air quality for a time near the release, typically do not spread contamination to secondary media through the air transport mechanism. However, organic vapors emanating from soils in the vadose zone can serve as an indicator of subsurface releases and potential soil contamination. The movement of organic vapors through soil is controlled by the specific properties of the contaminant and the soil as well as other physical parameters and physical characteristics of the soil.

### Surface Water

Surface soils and sediments may have been affected by releases that originated at the ground surface or releases that have surfaced from underground leaks. Precipitation runoff across these areas could then move the contamination into nearby drainages or surface impoundments. A system of collection ditches and ponds control runoff at the RFP. Some of these ditches and ponds are under investigation as separate IHSSs and sometimes separate OUs.

It is possible that surface water may also be indirectly affected by contaminated groundwater discharging to surface water bodies such as ditches, ponds, and creeks from natural seeps.

### Groundwater

Groundwater recharge from incident precipitation may occur through uncovered ground surfaces within the RFP. It is anticipated that mobile constituents of contamination in uncovered areas may eventually migrate into the vadose zone, or eventually to the groundwater system. Unlined drainages, both natural and manmade, are probably a primary source of groundwater recharge in the RFP. Contaminants underlying these sources can be expected to reach the water table more quickly. Soils overlain by pavement and buildings, on the other hand, may be subject to little

or no downward percolation of water, and contaminants in such soils may remain relatively immobile.

In the vadose (unsaturated) zone, free liquids are expected to move generally downward to the water table, which varies in the OU13 area from a few to more than 10 feet depending upon location and time of year. If, however, the leakage or release rate exceeds the infiltration capacity of the soil, or if the surface is covered with an impermeable material (i.e., asphalt), then the liquid may pool or flow across the material surface to a more permeable material where infiltration can occur. In an instance where the release is from a pressurized source (i.e., pressurized pipeline), or the rate of leakage from an underground release exceeds the soil's infiltration capacity, the release may rise to the surface. This has occurred during a number of historical pipeline and valve vault leaks at the RFP. Liquids infiltrating the soil may also encounter a less permeable layer (low-flow boundary) and flow laterally through the more permeable soil along the boundary. At the RFP, such permeability contrasts are likely at the alluvium/bedrock contact.

Most of the RFP pipelines are believed to be bedded either in sand or in native soil backfill. Hydraulic conductivity in clean sand ranges from approximately  $10^{-3}$  to 1 cm/sec. The hydraulic conductivity in the Rocky Flats Alluvium, the deposit in which the majority of the RFP pipelines are located, ranges from approximately  $1 \times 10^{-2}$  to  $7 \times 10^{-5}$  cm/sec. The Valley Fill Alluvium, another common deposit at the RFP, has a hydraulic conductivity that ranges from  $3 \times 10^{-3}$  to  $5 \times 10^{-6}$  cm/sec (EG&G, 1991d). The hydraulic conductivity of unconsolidated deposits such as the Rocky Flats Alluvium is expected to increase when the deposit is disturbed (i.e., excavated and replaced as backfill material) due to increased porosity in the disturbed material.

It is therefore considered likely that most pipeline releases initially flowed preferentially through the trench materials and permeated the surrounding native soils to a much lesser extent than the trench materials. Over time, the released materials may gradually have infiltrated surrounding

native soil, particularly the soil beneath the trench. Thus, contaminant plumes from pipeline releases are expected to be strongly aligned along pipeline trenches, and perhaps to extend below the trenches into underlying soils. Groundwater that may periodically or perennially saturate pipe trenches can also be expected to flow preferentially through the trench materials. Any resulting spread of contamination should remain strongly oriented along the trench.

Contaminant plumes resulting from slow, gradual pipeline leaks may be less prevalent along pipeline trenches than those from releases with higher flow rates. It is probable that many leaks occurred from the pipelines that were never detected due to low flow rate. It is also possible that some major releases were preceded at the same location by a longer period of slow leakage as the pipeline gradually failed. However, it is still considered likely that the relatively much higher hydraulic conductivity of the trench materials will control the orientation of contaminant plumes from gradual pipeline leaks, albeit to a lesser degree than those from more sudden releases.

Tank releases are most likely to occur at tank openings (i.e., overflows), tank/pipe connections, the base of the tank where residual waste collects, where underground tanks may be in contact with groundwater, at cold joints along the walls of concrete tanks, and at structural beams that could be affected by differential settlement of the tank bedding or supports.

Releases from such locations would likely affect the environment immediately surrounding the tank, particularly where the release is from an underground tank bedded in backfill. Based on these conceptual tank release locations, contamination will most likely exist beneath or near external connections and openings, near joints or corners around underground tanks, and beneath the base of the tank.

## 2.3.2 GROUP-SPECIFIC CONCEPTUAL MODELS

This Section presents a general summary of the OU13 characteristics by group followed by descriptions of group-specific contaminant sources, release mechanisms, transport media, exposure routes, and receptors. Section 2.6.2 is summarized in Figures 2-57 and 2-58. Descriptions of the backgrounds and physical settings of the IHSSs making up these groups were presented in Section 2.1. Section 2.2 presented detailed information on the nature and extent of contamination specific to each IHSS.

### 2.3.2.1 Group I: Releases Originating Above Ground and Affecting Surficial Materials

The IHSSs associated with Group I include the North Chemical Storage Site (117.1), the Middle Chemical Storage Site (117.2), the South Chemical Storage Site (117.3), the Oil Burn Pit 1 (128), the Lithium Metal Destruction Site (134), the Waste Spills (148), the Fuel Oil Tank (152), the North Area Radioactive Site (157.1), the Building 551 Radioactive Site (158), the Solvent Burning Ground (171), the Caustic Leak (190), and the Hydrogen Peroxide Spill (191). These IHSSs were grouped based on the location of the releases (primarily above ground) and the media affected (primarily surficial materials). Some IHSSs are included in both groups (IHSS 128 and IHSS 148) since releases associated with them may have affected media both at and below the ground surface. Figure 2-59 presents a schematic diagram of the conceptual model for Group I.

#### **IHSS 117.1--Chemical Storage North Site**

Presently this area is used for scrap metal storage and contractor trailer parking. A portion of the IHSS is located within the Protected Area. Included within its boundaries are a transformer, a valve vault, and two small buildings. The area is mostly paved, except for a small northeast-southwest trending strip. The primary contaminant sources at IHSS 117.1 are believed to have been contaminated scrap metal and building construction debris stored at the site at some point



# SURFACE SOIL CONTAMINATION

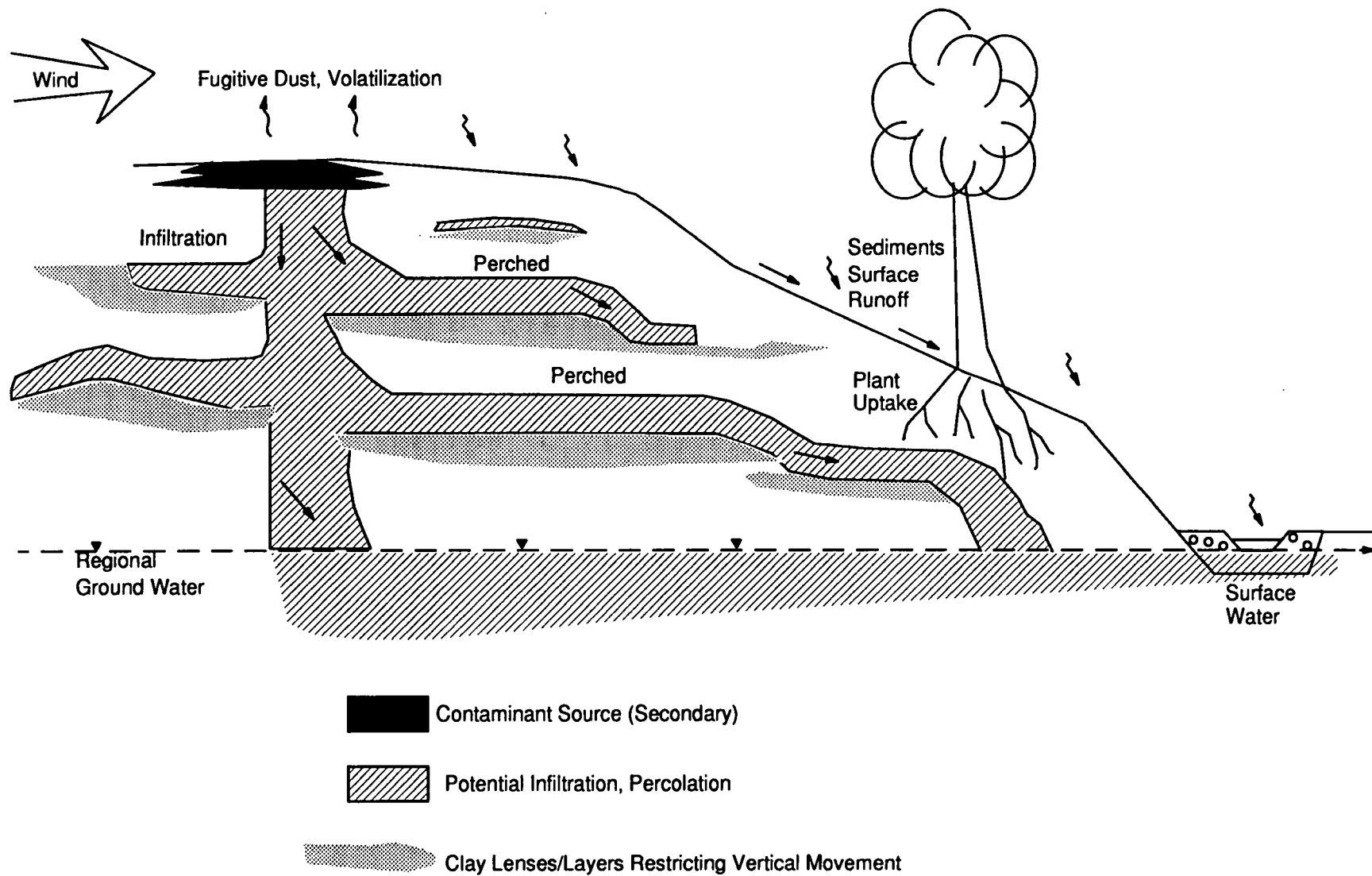


FIGURE 2-59  
GROUP I - CONCEPTUAL MODEL

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in its history. Transformers and automotive batteries may have also been stored and/or disposed of at the site.

The primary release mechanism associated with this IHSS has not been identified, though residues may have been leached from the scrap metal and construction debris.

### **IHSS 117.2--Chemical Storage Middle Site**

This area, which is currently paved, is used for outside storage. A large tent containing unknown materials exists within its boundaries. The primary contaminant sources at IHSS 117.2 are aluminum scrap metal, drums that contained unknown substances, and a drum that contained aluminum nitrate. Additional contaminant sources relating to this IHSS include uranium chips and turnings in an aluminum scrap pile, drums that contained beryllium chips and turnings, and a 55-gallon drum that contained aluminum nitrate. In 1974, the site was noted as being a non-radioactive storage yard at which acids, oils, soaps and solvents were stored.

The primary release mechanisms associated with this IHSS include leaks, spills and probably leaching.

### **IHSS 117.3--Chemical Storage South Site**

This site, at the corner of Central Avenue and Seventh Street is currently partially covered by Tank 224 which contains No. 6 fuel oil. This area is documented as having been used for storage of various unidentified materials from at least 1964 until 1970. The primary source at this IHSS is believed to have been a wooden waste box containing a glovebox, which in turn contained a highly contaminated residual oil. Since the glovebox originated in Building 776, it is believed that the contaminant was plutonium. The composition of the oil is unknown.

The release mechanism associated with this incident is a leak. The glovebox leaked the highly contaminated residual oil during transport along Central Avenue and on the ground in the storage area where the box was placed.

#### **IHSS 128--Oil Burn Pit No. 1**

The primary contaminant source at IHSS 128 is the Oil Burn Pit No. 1. Approximately 200 gallons of radioactively contaminated waste oil was burned at this location. It is speculated that there was disposal activity taking place in the same location prior to the oil burn experiment and that garage personnel may have burned waste motor oil in the pit prior to the burning of contaminated oil. This activity took place in an area now covered by Sage Avenue and its associated drainage ditch.

The primary release mechanisms for IHSS 128 are direct application of contaminated oil to an unlined oil burn pit and volatilization to the atmosphere through ignition of the oil.

#### **IHSS 134--Lithium Metal Destruction Site**

The primary contaminant source for IHSS 134 is from the destruction of lithium and magnesium. Lithium scrap was disposed of in the area north of Building 331 and currently under Building 335 from 1956 through 1966. Lithium and oil were burned together in a drum until that drum was full of ash and non-combustible residue. Fire-fighting training methods may have caused some residue to be expelled from the drum onto the ground around the immediate area. Two lithium explosion incidents may have caused lithium metal to be sprayed around the area behind the building and on the roof.

Although this IHSS addresses lithium destruction, magnesium destruction occurred far more frequently than lithium destruction in the area. The magnesium was typically destroyed in the area of the two small ponds that were believed to have been the Oil Burn Pit No. 1 described above. The magnesium was spread out on the ground in the area of the two ponds and ignited.

The magnesium was sprinkled with water to accelerate the burning. After the reaction was complete, the residue was left in place on the ground. Magnesium disposal was done in quantities of one or two 30-gallon drums approximately once a month.

The primary release mechanism for IHSS 134 is volatilization to the atmosphere through ignition of the lithium and magnesium. This ignition occasionally led to violent reactions and explosions.

### **IHSS 148--Waste Spills**

Several small spills of nitrate-bearing wastes are said to have occurred around the outside of Building 123. These wastes may have contained radionuclides. No evidence has been found to verify the occurrence of these spills. Therefore, the primary source at IHSS 148 is considered to be the PWL buried beneath Building 123. Another primary source associated with this site is evaporation of isopropyl ether.

The release mechanisms associated with IHSS 148 are leaks, spills, and volatilization. It has been reported that the PWL beneath Building 123, being constructed of a type of iron, probably leaked considerable amounts of waste without personnel being aware of the leak. Volatilization is a second release mechanism that has been reported at this IHSS. During the middle to late 1970s, isopropyl ether was placed onto sand to allow for its outdoor evaporation outside of Building 123.

### **IHSS 152--Fuel Oil Tank**

The primary contaminant source at IHSS 152 is fuel oil Tank 221 located east of Building 452. Tank 221 is a 800,000-gallon fuel oil storage tank that was originally constructed with a 140-foot by 140-foot earthen berm surrounding it. This tank contains fuel oil for the RFP's central steam plant when natural gas is not available.

The primary release mechanisms for IHSS 152 are leaks and spills from pipelines associated with Tank 221.

#### **IHSS 157.1--Radioactive Site North Area**

The primary contaminant source at IHSS 157.1 is considered to be the laundry building located at the corner of Fifth Street and Central Avenue. Before the building was converted to a filter test laboratory in approximately 1972, the building received contaminated clothing from Buildings 444 and 883 and non-contaminated clothing from other areas of the plant site. Building 444 handled depleted uranium and later beryllium. An incident in 1964 involved enriched uranium in clothing from Building 883 causing "some contamination" in Building 442. It is believed that Building 442 discharged its laundry effluent to the sanitary sewer, which then entered the waste water treatment plant (Building 995).

The release mechanism(s) associated with this IHSS have not been identified; however, it is speculated that leaks and/or spills may have contributed to the contamination.

#### **IHSS 158--Radioactive Site Building 551**

The primary contaminant source at IHSS 158 is considered to be waste boxes that were loaded into railroad container cars in this area, north of Building 551.

The release mechanism at this IHSS is speculated to be leakage of the waste boxes as they were being loaded into the railroad cars.

#### **IHSS 171--Solvent Burning Ground**

The primary contaminant source at IHSS 171 is considered to be residues from solvents used during fire-fighting training in and around Building 335. When this area was first used for training purposes, lithium residue in an oily sludge was burned (see also IHSSs 128 and 134).

The primary release mechanism for IHSS 171 is volatilization to the atmosphere through ignition of diesel, gasoline, lithium, magnesium, and possibly waste solvents.

#### **IHSS 190--Caustic Leak**

The primary contaminant source at IHSS 190 is the caustic storage tank located near the southeast corner of Building 443. The tank, located near the southeastern corner of Building 443, is an above-ground, steel, 3,000-gallon tank used for concentrated sodium hydroxide storage. The secondary containment of the tank is a 3,000-gallon holding basin.

The primary release mechanism for IHSS 190 is leakage from the caustic storage tank.

#### **IHSS 191--Hydrogen Peroxide Spill**

The primary contaminant source at IHSS 191 was a 55-gallon drum of hydrogen peroxide. During the week ending April 24, 1981, warehouse personnel were transporting three 55-gallon drums of hydrogen peroxide ( $H_2O_2$ ) when two of the drums fell off of a pallet. One of the drums burst open and the hydrogen peroxide drained into a culvert at the corner of Fifth Street and Central Avenue.

The primary release mechanism for IHSS 191 was a spill.

#### **Secondary Sources and Release Mechanisms**

It is possible that soils were contaminated at all of the IHSSs in Group I as a result of past releases.

It is possible that past releases have resulted in residual soil and groundwater contamination, at IHSS 117.1 and IHSS 117.2. In an effort to remediate the release at IHSS 117.3, contaminated soil was removed. However, it is possible that residual contamination still exists.

In the vicinity of the IHSSs where fire-fighting activities took place (128, 134, and 171), soil may have been affected as a result of splashes and fallout deposition. It is believed that these destruction sites were abandoned in place. Some of the affected soils were probably covered with fill and paved over for Sage Avenue. Soils that were left in place and undisturbed should be considered a secondary source. Since the activities associated with IHSS 171 occurred near what was then a natural drainage, groundwater may have also been impacted.

Surface soils at IHSS 148 may have residual isopropyl ether or peroxides; however they may have been removed at the time of the installation of a transformer that is currently located at this spot.

While contaminated soil from one of the spills at IHSS 152 was removed, it is possible that soil contaminated with hydrocarbons remains in the area of the tanks, especially within the berm. At IHSS 157.1, the incidents of depleted uranium contamination in the soil around Building 442 may have left residual uranium on the ground surface. Uranium may also have found its way to groundwater. Though groundwater may be contaminated beneath Building 442, the contamination may be the result of activities that occurred inside the building and not as a direct result of this IHSS's release.

Soil in the area of IHSS 158 has been impacted by construction events since the releases were believed to have occurred. If contaminated soil exists, it may be fairly deep.

It is improbable that there is residual soil impact from the incidents relating to IHSSs 190 and 191. Constituents related to the incident, such as sodium, aluminum, sulfur, hydrogen and oxygen, are all naturally occurring, and therefore the presence of these elements would not be indicative of the incident except by concentration.

It is possible that in addition to soils, sediments and groundwater have been affected at all of the IHSSs within this group. Therefore, soils, sediments, and groundwater should be considered as potential secondary sources.

Secondary release mechanisms associated with Group I's soil contamination are considered to be disturbance of soil resulting in volatilization and dispersion, then settling of fugitive dust; precipitation events resulting in sediment transport in ditches and streams, and infiltration; and movement of contaminated groundwater.

### Transport Media

Historical accounts of the IHSSs associated with Group I indicate that the releases could potentially have impacted the transport media of air, surface water, groundwater, and biota through pathways illustrated in Figure 2-57.

#### Air

Air should be considered a transport mechanism for Group I due to the likelihood of soils having been affected, and their consideration as a secondary source. Potential movement of contaminants by wind is possible wherever the ground surface is affected. The likelihood of airborne contamination increases greatly if the site is disturbed by traffic, construction, or similar activity. If the locations of the IHSSs have been covered with fill, the likelihood of airborne contamination from secondary sources decreases greatly.

Air transport of vapors emanating from volatile organic compound (VOC) spills, while impacting air quality for a time near the release, typically do not spread contamination to the unaffected media.



### Surface Water

Surface soils and sediments have been affected by releases that originated above the ground surface in Group I IHSSs. Activities associated with some of the IHSSs appear to have occurred near what at the time was a natural water course. At IHSS 152, contamination is known to have moved into nearby drainages. Precipitation runoff across these areas could also move the contamination into the nearby drainages or surface impoundments. A system of collection ditches and ponds, some of which are under investigation as separate IHSSs or separate OU's, control runoff at the RFP.

### Groundwater

Groundwater recharge from incident precipitation occurs through uncovered ground surfaces. All of the IHSSs associated with Group I probably occurred in and around uncovered ground surfaces. It is anticipated that mobile constituents of contamination in these uncovered areas may have leached down into the groundwater system prior to pavement of the area. Contaminated soils subsequently overlain by pavement and buildings may be subject to little or no infiltration of water, contaminants in such soils may remain relatively immobile.

Unlined drainages, both natural and manmade, are probably a primary source of groundwater recharge at the RFP. Contaminants underlying these features can be expected to reach the water table more quickly.

### Exposure Routes

Contaminants released from Group I IHSSs could potentially affect receptors through inhalation of airborne particles or vapors, and through ingestion of or dermal contact with contaminated source or transport media.

## Receptors

Potential human receptors may include the RFP workers and visitors to the site, and offsite residents. Environmental receptors include biota (both flora and fauna) indigenous to the Group I IHSS localities and their environs.

### 2.3.2.2 Group II: Releases Originating and Affecting Transport Media Below Ground Surface

The IHSSs associated with Group II include the Oil Burn Pit 1 (128), the Waste Spills (148) and Valve Vault 12 (186). These IHSSs were grouped together based on the releases originating primarily below ground surface. Figure 2-60 presents a schematic diagram of the conceptual model for Group II.

#### IHSS 128--Oil Burn Pit No. 1

The primary contaminant source at IHSS 128 is the Oil Burn Pit No. 1. Approximately 200 gallons of radioactively contaminated waste oil was burned at this location. It is speculated that there was disposal activity taking place in the same location prior to the oil burn experiment and that garage personnel may have burned waste motor oil in the pit prior to the burning of contaminated oil.

The primary release mechanisms for IHSS 128 are direct application of contaminated oil to an unlined oil burn pit and volatilization to the atmosphere through ignition of the oil.

#### IHSS 148--Waste Spills

The primary source at IHSS 148 is considered to be the process waste line (PWL) buried beneath Building 123. Another primary source associated with this site is evaporation of isopropyl ether. The release mechanisms associated with IHSS 148 are leaks, spills, and volatilization. It has been reported that the PWL beneath Building 123, being constructed of a type of iron, probably

# BURIED MATERIAL

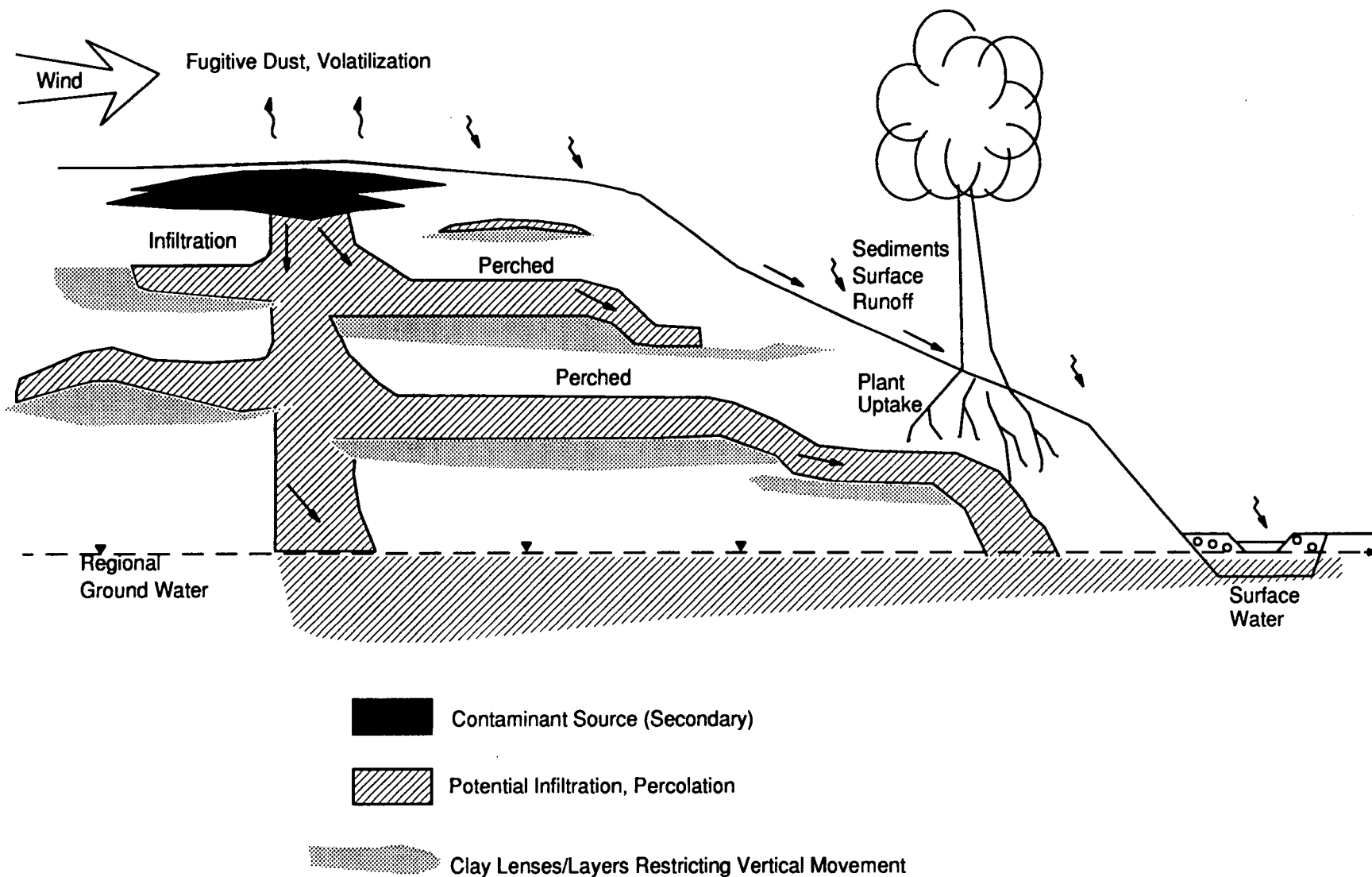


FIGURE 2-60  
GROUP II - CONCEPTUAL MODEL

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leaked considerable amounts of waste without personnel being aware of the leak. Volatilization is a second release mechanism that has been reported at this IHSS. During the middle to late 1970s, isopropyl ether was placed onto sand to allow for its outdoor evaporation outside of Building 123.

### **IHSS 186--Valve Vault 12**

The primary contaminant source at IHSS 186 is considered to be Valve Vault 12. Valve Vault 12 is part of the existing process waste system. It is located west of Building 552, east of a paved parking lot, south of the Protected Area, and north of the intersection of Sixth and Sage Streets. It contains pumps, transformers, breakers, switches, and a sump pump.

The release mechanism associated with this IHSS is leakage. Several leaks of process water have occurred in pipelines associated with Valve Vault 12.

### **Secondary Sources and Release Mechanisms**

Subsurface soils have been contaminated as a result of past releases associated with the IHSSs in Group II. It is likely that groundwater has also been affected. Residual ash and residue were probably left in place at IHSS 128, affecting soils which were subsequently filled and paved over. At IHSS 148, it is possible, if not likely that releases from the PWL under Building 123 affected groundwater. It is not likely that residual hydrogen peroxide remains in the soil due to natural dilution over time. It is probable that soil contamination still exists at IHSS 186 due to the large area which was initially impacted and the remaining radioactivity at the time of cleanup completion.

In light of this information, both soils and groundwater are considered potential secondary sources within this group.

Secondary release mechanisms associated with Group II's soil contamination are considered to be disturbance of soil resulting in volatilization and dispersion, then settling of fugitive dust; leaching of contaminants from the subsurface soils by percolating groundwater; and movement of contaminated groundwater.

### Transport Media

Historical accounts of the IHSSs associated with Group II indicate that the releases could potentially have impacted the transport media of air, surface water, groundwater, and biota through pathways illustrated in Figure 2-58.

#### Air

Air should be considered as a transport mechanism for Group II due to the likelihood of soils having been affected and their consideration as a secondary source. Potential movement of contaminants by wind is possible wherever the ground surface is affected. The likelihood of airborne contamination increases greatly if the site is disturbed by traffic, construction, or similar activity.

#### Surface Water

Precipitation runoff across affected areas could move the contamination into nearby drainages or surface impoundments. A system of collection ditches and ponds, some of which are under investigation as separate IHSSs, and sometimes separate OUs, control runoff at the RFP.

#### Groundwater

Groundwater recharge from incident precipitation occurs through uncovered ground surfaces within some of the IHSSs associated with Group II. It is anticipated that mobile constituents of contamination in uncovered areas will eventually leach into the groundwater. Unlined drainages, both natural and manmade, are probably a primary source of groundwater recharge in the RFP, and contaminants underlying these features can be expected to reach the water table more

quickly. Contaminated soils subsequently overlain by pavement and buildings may be subject to little or no infiltration of water, contaminants in such soils may remain relatively immobile.

In addition to contaminant migration to the water table, it is possible that direct releases to groundwater have occurred at IHSSs that involve underground storage tanks. The water table at the RFP has been known to fluctuate several feet. During seasonal highs in the water table fluctuation cycle, the water table could rise above the base of the tank, making direct contamination likely.

### Exposure Routes

Contaminants released from Group II IHSSs could potentially affect receptors through inhalation of airborne particles or vapors and through ingestion of or dermal contact with contaminated source or transport media.

### Receptors

Potential human receptors include the RFP workers and visitors, and offsite residents. Environmental receptors include biota (both flora and fauna) indigenous to the Group II IHSS environs.

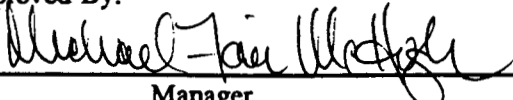
ROCKY FLATS PLANT  
Phase I RFI/RI Work Plan  
Operable Unit 13  
100 Area

Manual  
Section No.:  
Page:  
Organization: 21100-WP-OU13.01  
3.0, REV. 0  
1 of 3  
Environmental Management

TITLE: Benchmarks

Approved By:

02/01/93  
Effective Date

  
Manager

10/9/92  
Date

### 3.0 ROCKY FLATS PLANT CHEMICAL SPECIFIC BENCHMARKS

Tables 3.1 through 3.4 provide a preliminary identification of potential chemical-specific Benchmarks for groundwater and surface water at RFP. Chemical-specific Benchmarks for soil have not been developed at this time. EPA analytical methods and detection limits have been specified for soil analyses to obtain data of the highest quality with the lowest possible detection limits. The Benchmarks included in this section were developed for the entire Rocky Flats Plant site and are not specific to OU13. Site specific ARARs will be developed as the initial step of the Corrective Measures Study for OU13. As validated data become available from RFI/RI investigations obtained pursuant to this Work Plan, the Benchmarks will be reevaluated in accordance with Chapter Three, Part 15 of the IAG (DOE, 1991a). The site-wide Benchmarks included in this work plan are not intended for use in establishing cleanup goals; however, they will be used to establish RFI/RI analytical detection limits. Cleanup criteria for OU13 will be site specific and shall be based on results of an environmental and human-based Risk Assessment.

The Colorado Department of Health and the Environmental Protection Agency have advanced the concept of establishing Applicable or Relevant Appropriate Requirements (ARARs) on a site-wide (all Rocky Flats OUs) basis. The Department of Energy, on the other hand, believes that ARARs should be established on a site (OU) specific basis so that OU-specific knowledge and individual site characteristics can be considered in the process. This OU by OU approach is consistent with the National Contingency Plan and EPA guidance. In order to meet the agencies

needs, a list of Chemical Specific Benchmarks has been developed. This is a master list of possible contaminants which may be present across the entire Rocky Flats Plant site. This list provides identification of the compound, a listing of federal and state regulations that may apply to that compound, the Practical Quantitation Limit (PQL), which is the level at which the amount of analyte can be reliably measured, and the method of analysis which the PQL is based upon.

In some cases the Minimum Detection Limit (MDL) is listed instead of the PQL. The MDL is the lowest concentration at which the analyte can be detected but not necessarily measured.

Rocky Flats has been following the historical CERCLA/RCRA procedure of utilizing transitional EPA Contract Analytical Program (CLP) Routine Analytical Service protocol for Phase 1 study. This methodology is described as a managed approach whereby:

1. The benchmark table will be used in the Phase I investigations in conjunction with the CLP-RAS analytical methods to scope the initial RFI/RI investigation<sup>1</sup>.
2. Following receipt and analysis of all field investigation data, a weight-of-evidence evaluation will be used to assess the adequacy of the analytical program relative to study objectives<sup>2</sup>.

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<sup>1</sup> CLP-RAS methods are the workhorses of the hazardous waste industry. Collectively, a full CLP-RAS suite includes 126 organic (and a specified number of Tentatively Identified Compounds (TICs), and 25 inorganic compounds. Standard radiochemistry analysis includes 12 radioisotopes. These broad-brush methods provide a reasonable trade-off between specificity (the number of compounds detectable) and sensitivity (detection limit). It is standard practice to utilize CLP-RAS methods in the first phase of a study where contaminant identification is emphasized more than quantitation. Following identification of contaminants of concern, follow up sampling and analysis with a more sensitive method can be performed if quantitation is still an issue. This step-wise methodology was used in the OU1 881 Hillside Phase III study and the OU2 903 Pad and East Trenches, Phase II study.

<sup>2</sup> The weight-of-evidence evaluation will consider factors such as the number of detections of specific chemicals, observed concentration range, fate and transport characteristics, their occurrence-distribution and concentration relative to overall site risk, as well as likely ARAR determination.



3. If the weight-of-evidence evaluation suggests that a particular compound or group of compounds warrant further assessment at lower quantitation limits, then follow up sampling and analysis with Special Analytical Services (SAS) will be performed as necessary.

Site wide Benchmarks represented in Table 3.1 through 3.4 were developed from the following sources:

- Colorado Department of Health (CDH), Water Quality Control Commission (WQCC), groundwater standards;
- Safe Drinking Water Act (SWADA), Maximum Contaminant Levels (MCLs), surface water and groundwater;
- Clean Water Act (CWA), Ambient Water Quality Criteria (AWQC), potentially applicable to surface water and groundwater;
- RCRA, Subpart F, Groundwater Concentration Limits (40 CFR 264.94), groundwater standards; and
- CDH, WQCC proposed statewide and classified groundwater area standards.

In instances where Benchmarks have not been proposed for a particular chemical or for a particular type of investigative method, EG&G's General Radiochemistry and Routine Analytical Services Protocol (GRRASP) or other appropriate laboratory procedures will be considered as the practical quantitation limits and will be applied.

**TABLE 3.1. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)**  
**GROUND WATER QUALITY STANDARDS**

					FEDERAL STANDARDS					STATE STANDARDS							
Parameter - CAS No.	Type (5)	PQL MDL		(6)	SDWA Maximum Contaminant Level (a) ug/l	SDWA Maximum Contaminant Level (b) ug/l	SDWA Maximum Contaminant Level Goals (a) ug/l	SDWA Maximum Contaminant Level Goals (b) ug/l	RCRA Subpart F Limit (c) ug/l	CDH CWQCC Groundwater Quality Standards (d)							
		RFP ug/l	CDH ug/l							Statewide	Site-Specific (g)						
										Table A (d) (7) ug/l	Table 1 Human Health ug/l	Table 2 Secondary Drinking ug/l	Table 3 Agriculture ug/l	Table 4 TDS ug/l	Table 5 Chronic ug/l	Table 6 Radionuclides	
															Woman Creek pCi/l	Walnut Creek pCi/l	
Bicarbonate -	A	10,000		E310.1													
Carbonate -	A	10,000		E310.1													
Chloride -	A	5,000		E325	250,000 *							250,000					
Chlorine 7782-50-5	A	1,000		E4500													
Fluoride -	A	5,000		E340	4,000; 2,000*		4,000			4,000			2,000				
N as Nitrate -	A	5,000		E353.1	10,000			10,000		10,000							
N as Nitrate+Nitrite -	A	5,000		E353.1		10,000		10,000					100,000				
N as Nitrite -	A	5,000		E354.1		1,000		1,000		1,000			10,000				
Sulfate -	A	5,000		E375.4	250,000*							250,000					
Sulfide -	A																
Coliform (total) -	B	1		SM9221C	1/100 ml						1/100 ml						
Ammonia as N -	C	5,000		E350													
Dioxin 1746-01-6	D		0.01(9)	d						0.00000022					0.000000013		
Sulfur	E	100,000		E600													
Dissolved Oxygen (mg/l)	FP	500		SM4500													
pH -	FP	0.1		E150.1	6.5-8.5 *							6.5-8.5	6.5-8.5				
Specific Conductance - (uS/cm)	FP	1		E120.1													
Temperature -	FP																
Boron	I	5,000		E6010									750				
Total Dissolved Solids -	I	10,000		E160.1	500,000*									400,000 (1)			
Aluminum 7429-90-5	M	200		CT		50 to 200*							5,000				
Antimony 7440-36-0	M	50		CT													
Arsenic 7740-38-2	M	10		CT	50				50		50		100				
Arsenic III -	M																
Arsenic V -	M																
Barium 7440-39-3	M	200		CT	1,000	2,000 (e)		2,000 (e)	1,000		1,000						
Beryllium 7440-41-7	M	5		CT													
Cadmium 7740-43-9	M	5		E213.2	10	5		5	10		10		10				
Calcium 7440-70-2	M	5,000		CT													
Cesium 7440-46-2	M	1,000		NC													
Chromium 7440-47-3	M	10		E218.2	50	100		100	50		50		100				
Chromium III -	M	5		SW8467196													
Chromium VI -	M	10		E218.5													
Cobalt 7440-48-4	M	50		CT													
Copper 7440-50-8	M	25		E220.2	1,000 *			1,300 (f)				1,000	200				
Cyanide -	M	10		E335.2							200						
Iron -	M	100		CT	300 *							300	5,000				
Lead 7439-92-1	M	5		E239.2	50			0 (f)	50		50						
Lithium 7439-93-2	M	100		NC													
Magnesium 7439-95-4	M	5000		CT													
Manganese 7439-96-5	M	15		CT	50 *							50	200				
Mercury 7439-97-6	M	0.2		CT	2	2		2	2		2		10				

**TABLE 3.1. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)**  
**GROUND WATER QUALITY STANDARDS**

					FEDERAL STANDARDS					STATE STANDARDS									
Parameter - CAS No.	Type (5)	PQL MDL		(6)	SDWA Maximum Contaminant Level (a) ug/l	SDWA Maximum Contaminant Level (b) ug/l	SDWA Maximum Contaminant Level Goals (a) ug/l	SDWA Maximum Contaminant Level Goals (b) ug/l	RCRA Subpart F Limit (c) ug/l	CDH CWQCC Groundwater Quality Standards (d)									
		RFP ug/l	CDH ug/l							Statewide	Site-Specific (g)						Table 5 Chronic ug/l	Table 6 Radionuclides	
										Table A (d) (7) ug/l	Table 1 Human Health ug/l	Table 2 Secondary Drinking ug/l	Table 3 Agriculture ug/l	Table 4 TDS ug/l	Woman Creek pCi/l	Walnut Creek pCi/l			
Manganese 7439-96-5	M	15		CT	50 *							50	200						
Mercury 7439-97-6	M	0.2		CT	2	2		2	2		2		10						
Molybdenum 7439-93-7	M	200		NC															
Nickel 7440-02-0	M	40		CT									200						
Potassium 7440-09-7	M	5000		CT															
Selenium 7782-49-2	M	5		CT	10	50		50	10		10		20						
Silver 7440-22-4	M	10		E272.2	50	100 *			50		50								
Sodium 7440-23-5	M	5000		CT															
Strontium -	M	200		NC															
Thallium 7440-28-0	M	10		CT															
Tin 7440-31-5	M	200		NC															
Titanium 7440-32-6	M	10		E6010															
Tungsten 7440-33-7	M	10		E6010															
Vanadium 7440-62-2	M	50		CT									100						
Zinc 7440-66-6	M	20		CT	5,000 *							5,000	2,000						
2,4,5-TP Silvex	P		0.5	d	10	50		50	10	50									
2,4-Dichlorophenoxyacetic Acid (2,4-D) 94-75-7	P		1	d	100	70		70	100	70									
Acrotoxin 107-02-8	P		10																
Aldicarb 116-06-3	P		10			3 (e)		1 (e)		10									
Aldrin 309-00-2	P	0.05	0.1	E508						0.002					0.000074				
Bromacil -	P																		
Carbofuran 1563-66-2	P			d		40		40		36									
Chloranil -	P																		
Chlordane (Alpha) 57-74-9	P	0.5	1	E508		2		0		0.03					0.00046				
Chlordane (Gamma) 57-74-9	P	0.5	1	E508		2		0		0.03					0.00046				
Chlorpyrifos 2921-88-2	P			E619															
DDT 50-29-3	P	0.1	0.1	E508						0.1					0.000024				
DDT Metabolite (DDD) -	P	0.1		CP															
DDT Metabolite (DDE) -	P	0.1	0.1	CP						0.1									
Demeton 8065-48-3	P																		
Diazinon 333-41-5	P																		
Dieldrin 60-57-1	P	0.1	0.1	CP						0.002					0.000071				
Endosulfan I 959-95-8	P	0.05		CP															
Endosulfan II 33213-65-9	P	0.1		CP															
Endosulfan sulfate 1031-07-8	P	0.1		CP															
Endrin 72-20-8	P	0.1	0.1	CP	0.2				0.2	0.2									
Endrin Aldehyde 7421-93-4	P		0.1							0.2									
Endrin Ketone	P	0.1		CP															
Guthion 86-50-0	P																		
Heptachlor 76-44-8	P	0.05	0.05	CP		0.4		0		0.008					0.00028				
Heptachlor Epoxide 1024-57-3	P	0.05	0.05	CP		0.2		0		0.09									

**TABLE 3.1. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)**  
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Parameter - CAS No.	Type (5)	FEDERAL STANDARDS								STATE STANDARDS							
		PQL MDL		(6)	SDWA Maximum Contaminant Level (a) ug/l	SDWA Maximum Contaminant Level (b) ug/l	SDWA Maximum Contaminant Level Goals (a) ug/l	SDWA Maximum Contaminant Level Goals (b) ug/l	RCRA Subpart F Limit (c) ug/l	CDH CWQCC Groundwater Quality Standards (d)							
										Statewide Table A (d) (7) ug/l	Site-Specific (g)						
		RFP ug/l	CDH ug/l								Table 1 Human Health ug/l	Table 2 Secondary Drinking ug/l	Table 3 Agriculture ug/l	Table 4 TDS ug/l	Table 5 Chronic ug/l	Table 6 Radionuclides	
																Woman Creek pCi/l	Wabash Creek pCi/l
Hexachlorocyclohexane, Alpha 608-73-1	P	0.05	0.05	E505						0.006					0.0092		
Hexachlorocyclohexane, Beta 608-73-1	P	0.05	0.1(9)	E505											0.0163		
Hexachlorocyclohexane, BHC 608-73-1	P		0.05														
Hexachlorocyclohexane, Delta 608-73-1	P	0.05		CP													
Hexachlorocyclohexane, Tech 608-73-1	P		0.5(9)												0.0123		
Hexachlorocyclohexane, Lindane 58-89-9	P	0.05	0.05	E505	4	0.2		0.2	4.0	0.2					0.0186		
Malathion 121-75-5	P																
Methoxychlor 72-43-5	P	0.5	0.5	CP	100	40		40	100	40	100						
Mirex 2385-85-5	P																
Parathion 56-38-2	P																
PCBs 1336-36-3	P	0.5	1	E508		0.5		0		0.005					0.000079		
Simazine -	P			a,E608(1)/ 507(2)											4		
Toxaphene 8001-35-2	P	1	5	CP		3		0	5.0	0.03	5						
Vaponite 2 -	P																
Aroclor 1016 12674-11-2	PP	0.5		CP													
Aroclor 1221 11104-28-2	PP	0.5		CP													
Aroclor 1232 11141-16-5	PP	0.5		CP													
Aroclor 1242 53469-21-9	PP	0.5		CP													
Aroclor 1248 12672-29-6	PP	0.5		CP													
Aroclor 1254 11097-69-1	PP	1		CP													
Aroclor 1260 11096-82-5	PP	1		CP													
Atrazine 1912-24-9	PP		1 (9)	a,E608(1)/ 507(2)		3		3							3		
Americium (pCi/l) -	R															0.05	0.05
Americium 241 (pCi/l) -	R	0.01															
Cesium 134 (pCi/l) -	R	1								80 (2)						80	80
Cesium 137 (pCi/l)	R	1															
Gross Alpha (pCi/l)	R	2			15 (8)						15(8)					7	11
Gross Beta (pCi/l)	R	4			50 (4 mrem/yr)						4 mrem/yr					5	19
Plutonium (pCi/l)	R															0.05	0.05
Plutonium 238+239+240 (pCi/l)	R	0.01								15 (2)							
Radium 226+228 (pCi/l)	R	0.5/1.0 (4)			5					5 (2)							
Strontium 89+90 (pCi/l)	R	1															
Strontium 90 (pCi/l)	R									8 (2)						8	8
Thorium 230+232 (pCi/l)	R									60 (2)							
Tritium (pCi/l)	R				20,000 (3)					20,000 (2)						500	500

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		RFP ug/l	CDH ug/l							Statewide	Site-Specific (g)						
										Table A (d) (7) ug/l	Table 1 Human Health ug/l	Table 2 Secondary Drinking ug/l	Table 3 Agriculture ug/l	Table 4 TDS ug/l	Table 5 Chronic ug/l	Table 6 Radionuclides	
																Woman Creek pCi/l	Walnut Creek pCi/l
Uranium 233+234 (pCi/l)	R																
Uranium 235 (pCi/l)	R	0.6															
Uranium 238 (pCi/l)	R	0.6															
Uranium (Total) (pCi/l)	R															5	10
1,2,4,5-Tetrachlorobenzene 95-94-3	SV		10	b						2							
1,2,4-Trichlorobenzene	SV	10		CS													
1,2-Dichlorobenzene (Ortho) 95-50-1	SV	10	1	CS		600		600		620							
1,2-Diphenylhydrazine 122-66-7	SV			b						0.05							
1,3-Dichlorobenzene (Meta) 541-73-1	SV	10	1	CS						620							
1,4-Dichlorobenzene (Para) 106-46-7	SV	10	1	CS	75		75			75							
2,4,5-Trichlorophenol 95-95-5	SV	50		CS						700							
2,4,6-Trichlorophenol 88-06-2	SV	10	50	E502.2						2					1.2		
2,4-Dichlorophenol 120-83-2	SV	10	50	CS						21							
2,4-Dimethylphenol 105-67-9	SV	10		CS													
2,4-Dinitrophenol 51-28-5	SV	50	50	CS						14							
2,4-Dinitrotoluene 25321-14-6	SV	10		CS													
2,6-Dinitrotoluene 25321-14-6	SV	10		CS													
2-Chloronaphthalene 91-58-7	SV	10		CS													
2-Chlorophenol 95-57-8	SV	10		CS													
2-Methylnaphthalene 1321-94-4	SV	10		CS													
2-Methylphenol 1319-77-3	SV	10		CS													
2-Nitroaniline 100-01-6	SV	50		CS													
2-Nitrophenol 88-75-5	SV	10		CS													
3,3-Dichlorobenzidine 91-94-1	SV	20		E625													
3-Nitroaniline 100-01-6	SV	50		CS													
4,6-Dinitro-2-methylphenol -	SV	50		CS													
4-Bromophenyl Phenylether 101-55-3	SV	10		CS													
4-Chloroaniline -	SV	10		CS													
4-Chlorophenyl Phenyl Ether 7005-72-3	SV	10		CS													
4-Chloro-3-methylphenol	SV	10		CS													
4-Methylphenol -	SV	10		CS													
4-Nitroaniline 100-01-6	SV	50		CS													
4-Nitrophenol 100-02-7	SV	50		CS													
Acenaphthene 83-32-9	SV	10		CS													
Anthracene 120-12-7	SV	10		CS													
Benidine 92-87-5	SV		10	dE625						0.0002	0.1				0.00012		
Benzoic Acid 65-85-0	SV	50		CS													

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**GROUND WATER QUALITY STANDARDS**

					FEDERAL STANDARDS					STATE STANDARDS						
Parameter - CAS No.	Type (5)	PQL MDL		(6)	SDWA Maximum Contaminant Level (a) ug/l	SDWA Maximum Contaminant Level (b) ug/l	SDWA Maximum Contaminant Level Goals (a) ug/l	SDWA Maximum Contaminant Level Goals (b) ug/l	RCRA Subpart F Limit (c) ug/l	CDH CWQCC Groundwater Quality Standards (d)						
		RFP ug/l	CDH ug/l							Statewide	Site-Specific (g)					
										Table A (d) (7) ug/l	Table 1 Human Health ug/l	Table 2 Secondary Drinking ug/l	Table 3 Agriculture ug/l	Table 4 TDS ug/l	Table 5 Chronic ug/l	Table 6 Radionuclides
															Woman Creek pCi/l	Walnut Creek pCi/l
Benzo(a)anthracene 56-55-3	SV	10		CS												
Benzo(a)pyrene 50-32-8	SV	10		CS												
Benzo(b)fluoranthene 205-99-2	SV	10		CS												
Benzo(g,h,i)perylene 191-24-2	SV	10		CS												
Benzo(k)fluoranthene 207-09-9	SV	10		CS												
Benzyl Alcohol 100-51-6	SV	10		CS												
bis(2-Chloroethoxy)methane -	SV	10		CS												
bis(2-Chloroethyl)ether 111-44-4	SV	10		E625						0.03					0.0000037	
bis(2-Chloroisopropyl)ether -	SV	10		CS												
bis(2-Ethylhexyl)phthalate -	SV	10		CS												
Butadiene 106-99-0	SV															
Butylbenzylphthalate -	SV	10		CS												
Chlorinated Ethers -	SV															
Chlorinated Naphthalenes	SV															
Chloroalkylethers -	SV	10		CS												
Chlorophenol -	SV										1					
Chrysene 218-01-9	SV	10		CS												
Dibenzofuran 132-64-9	SV	10		CS												
Dibenz(a,h)anthracene 53-70-3	SV	10		CS												
Dichlorobenzenes 95-50-1	SV															
Dichlorobenzidine 91-94-1	SV	20	10(9)	E625											0.01	
Diethylphthalate -	SV	10		CS												
Dimethylphthalate -	SV	10		CS												
Di-n-butylphthalate -	SV	10		CS												
Di-n-octylphthalate -	SV	10		CS												
Ethylene Glycol 107-21-1	SV			d						7,000						
Fluoranthene 206-44-0	SV	10		CS												
Fluorene 86-73-7	SV	10		CS												
Formaldehyde 50-00-0	SV															
Haloethers -	SV															
Hexachlorobenzene 118-74-1	SV	10	10	E525						6					0.00072	
Hexachlorobutadiene 87-68-3	SV	10	10	E525						1					0.45	
Hexachlorocyclopentadiene 77-47-4	SV	10		CS						49						
Hexachloroethane	SV	10		E525											1.9	
Hydrazine 302-01-2	SV															
Indeno(1,2,3-cd)pyrene	SV	10		CS												
Isophorone 78-59-1	SV	10	10	CS						1,050						
Naphthalene 91-20-3	SV	10		CS												
Nitrobenzene 98-95-3	SV	10	10	CS						3.5						
Nitrophenols -	SV															
Nitrosamines -	SV		10													
Nitrosodibutylamine 924-16-3	SV			b,E607											0.0064	
Nitrosodiethylamine 55-18-5	SV		10	b,E607											0.0008	

**TABLE 3.1. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)**  
**GROUND WATER QUALITY STANDARDS**

					FEDERAL STANDARDS					STATE STANDARDS							
Parameter - CAS No.	Type (5)	PQL MDL		(6)	SDWA Maximum Contaminant Level (a) ug/l	SDWA Maximum Contaminant Level (b) ug/l	SDWA Maximum Contaminant Level Goals (a) ug/l	SDWA Maximum Contaminant Level Goals (b) ug/l	RCRA Subpart F Limit (c) ug/l	CDH CWQCC Groundwater Quality Standards (d)							
		RFP ug/l	CDH ug/l							Statewide	Site-Specific (g)						
										Table A (d) (7) ug/l	Table 1 Human Health ug/l	Table 2 Secondary Drinking ug/l	Table 3 Agriculture ug/l	Table 4 TDS ug/l	Table 5 Chronic ug/l	Table 6 Radionuclides	
																Woman Creek	Walnut Creek
Nitrosodimethylamine 62-75-9	SV		10	b,E607											0.0014		
Nitrosopyrrolidine 930-85-2	SV		10	b,E625											0.016		
N-Nitrosodiphenylamine 86-30-6	SV	10	10(9)	b,E607											4.9		
N-Nitroso-di-n-propylamine -	SV	10		CSb													
Pentachlorinated Ethanes -	SV			b													
Pentachlorobenzene 608-93-5	SV		10	b						6 (7)							
Pentachlorophenol 87-86-5	SV	50	50	CS		1 (e)		0 (e)		200							
Phenanthrene 85-01-8	SV	10		CS													
Phenol 108-95-2	SV	10		CS							1						
Phthalate Esters -	SV																
Polynuclear Aromatic Hydrocarbons	SV		1 (9)	b,E610											0.0028		
Vinyl Chloride 75-01-4	SV	10	2	CV	2		0			2							
1,1,1-Trichloroethane 71-55-6	V	5	1	CV	200		200			200							
1,1,2,2-Tetrachloroethane 79-34-5	V	5	1 (9)	CV											0.17		
1,1,2-Trichloroethane 79-00-5	V	5	1	E502.2						3					0.6		
1,1-Dichloroethane 75-34-3	V	5		CV													
1,1-Dichloroethene -	V	5	1	CV	7		7			7							
1,2-Dichloroethane 107-06-2	V	5	1	CV	5		0			0.4							
1,2-Dichloroethene (cis) -	V		1	a		70		70		70							
1,2-Dichloroethene (total) -	V	5		CV													
1,2-Dichloroethene (trans) -	V		1	a		100		100		100							
1,2-Dichloropropane 78-87-5	V	5	1	CV		5		0		0.56							
1,3-Dichloropropene (cis) 542-75-6	V	5		CV													
1,3-Dichloropropene (trans) 542-75-6	V	5		CV													
2-Butanone 78-93-3	V	10		CV													
2-Hexanone 591-78-6	V	10		CV													
4-Methyl-2-pentanone 108-10-1	V	10		CV													
Acetone 67-64-1	V	10		CV													
Acrylonitrile 107-13-1	V		15(9)	c,E625											0.058		
Benzene 71-43-2	V	5	1	CV	5		0			1							
Bromodichloromethane 75-27-4	V	5	1	CV						0.3							
Bromoform 75-25-2	V	5	1	CV						4							
Bromomethane 74-83-9	V	10		CV													
Carbon Disulfide 75-15-0	V	5		CV													
Carbon Tetrachloride 56-23-5	V	5	1	CV	5		0			0.3							
Chlorinated Benzenes -	V	10		CV/CS													
Chlorobenzene 108-90-7	V	5	1	CV/CS		100		100		100							
Chloroethane 75-00-3	V	10		CV													
Chloroform 67-66-3	V	5	1	E502.2	Tot THM <100**					6					0.19		
Chloromethane 74-87-3	V	10		CV													

**TABLE 3.1. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)**  
**GROUND WATER QUALITY STANDARDS**

					FEDERAL STANDARDS					STATE STANDARDS									
Parameter - CAS No.	Type (5)	PQL MDL		(6)	SDWA Maximum Contaminant Level (a) ug/l	SDWA Maximum Contaminant Level (b) ug/l	SDWA Maximum Contaminant Level Goals (a) ug/l	SDWA Maximum Contaminant Level Goals (b) ug/l	RCRA Subpart F Limit (c) ug/l	CDH CWQCC Groundwater Quality Standards (d)									
		RFP ug/l	CDH ug/l							Statewide Table A (d) (7) ug/l	Site-Specific (g)						Table 5 Chronic ug/l	Table 6 Radionuclides	
											Table 1 Human Health ug/l	Table 2 Secondary Drinking ug/l	Table 3 Agriculture ug/l	Table 4 TDS ug/l	Woman Creek pCi/l	Walnut Creek pCi/l			
Dibromochloromethane -	V	5	1	CV						14									
Dichloroethenes -	V																		
Ethyl Benzene 100-41-4	V	5	1	CV		700		700		580									
Ethylene Dibromide 106-93-4	V			d		0.05		0		0.0004									
Ethylene Oxide 75-21-8	V																		
Halomethanes -	V		1 (9)	ES02.2	100					100					0.19				
Methylene Chloride 75-09-2	V	5		CV															
Pyrene 129-00-0	V	10		CS															
Styrene 100-42-5	V	5		CV		100		100											
Tetrachloroethanes 79-34-5	V	5		ES02.2															
Tetrachloroethene -	V	5	1	CV		5		0		5					0.8				
Toluene 108-88-3	V	5	1	CV		1,000		1,000		1,000									
Trichloroethanes 79-00-5	V	5		ES02.2															
Trichloroethene 79-01-6	V	5	1	CV	5		0			5									
Vinyl Acetate 75-01-4	V	10		CV															
Xylenes (total) 1330-20-7	V	5		CV		10,000		10,000											

**EXPLANATION OF TABLE**

\* = secondary maximum contaminant level

\*\* = total trihalomethanes: chloroform, bromoform, bromodichloromethane, dibromochloromethane

CDH	= Colorado Department of Health
CLP	= Contract Laboratory Program
EPA	= Environmental Protection Agency
pCi/l	= picocuries per liter
PCB	= polychlorinated biphenyl
PQL	= Practical Quantitation Limit
RCRA	= Resource Conservation and Recovery Act
RFP	= Rocky Flats Plant
SDWA	= Safe Drinking Water Act
TAL	= Target Analyte List
THM	= Total Trihalomethanes
TIC	= Tentatively Identified Compound
MDL	= Minimum Detection Limit for radionuclides (pCi/l)
ug/l	= micrograms per liter
VOA	= Volatile Organic Analysis
CWQCC	= Colorado Water Quality Control Commission

(1) TDS standard - see Table 4 in (d); standard is 400 mg/l or 1.25 times the background level, whichever is least restrictive

(2) radionuclide standards - see sec. 3.11.5(c)2 in (d)

(3) If both strontium-90 and tritium are present, the sum of their annual dose equivalents to bone marrow shall not exceed 4 mrem/yr.

(4) MDL for Radium 226 is 0.5; MDL for radium 228 is 1

(5) type abbreviations are: A=anion; B=bacteria; C=cation; D=dioxin; E=element; FP=field parameter; I=indicator; M=metal; P=pesticide; PP=pesticide/PCB;



**TABLE 3.1. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)**  
**GROUND WATER QUALITY STANDARDS**

					FEDERAL STANDARDS					STATE STANDARDS								
Parameter - CAS No.	Type (5)	PQL MDL		(6)	SDWA Maximum Contaminant Level (a) ug/l	SDWA Maximum Contaminant Level (b) ug/l	SDWA Maximum Contaminant Level Goals (a) ug/l	SDWA Maximum Contaminant Level Goals (b) ug/l	RCRA Subpart F Limit (c) ug/l	CDH CWQCC Groundwater Quality Standards (d)								
		RFP ug/l	CDH ug/l							Statewide Table A (d) (7) ug/l	Site-Specific (g)						Table 6 Radionuclides Woman Creek pCi/l	Walnut Creek pCi/l
											Table 1 Human Health ug/l	Table 2 Secondary Drinking ug/l	Table 3 Agriculture ug/l	Table 4 TDS ug/l	Table 5 Chronic ug/l			

R=radionuclide; SV=semi-volatile; V=volatile

(6) method abbreviations are: CT=CLP-TAL; NC=non-CLP; CV=CLP-VOA; CS=CLP-SEMI; EP=EPA-PEST; CP=CLP-PEST; E=EPA; a = detected as total in CV; b = detected as TICs in CS; c = detected as TIC in CV;

d = not routinely monitored; e = monitored in discharge ponds; f = mixture-individual isomers detected.

(7) Where standard is below (more stringent than) PQL (CDH), PQL is standard.

(8) Value for gross alpha excludes uranium.

(9) Value is CDH detection level (PQL not available)

(a) EPA National Primary and Secondary Drinking Water Regulations, 40 CFR 141 and 40 CFR 143 (as of 5/1990)

(b) EPA National Primary and Secondary Drinking Water Regulations, 40 CFR Parts 141, 142, 143, Final Rule, Effective July 30, 1992 (56 Federal Register 3526; 1/30/1991)

(c) NCP, 40 CFR 300; NCP Preamble 55 FR 8764; CERCLA Compliance with Other Laws Manual, EPA/540/G-89/006, August 1988, 40 CFR 264.94.

(d) CDH/Colorado Water Quality Control Commission, The Basic Standards for Ground Water, 3.11.0 (5 CCR 1002-8) 1/5/1987 amended 11/30/1991; statewide radioactive standards listed in 3.11.5(c)(2).

(e) EPA National Primary and Secondary Drinking Water Regulations, 40 CFR Parts 141, 142, 143, Final Rule, Effective January 1, 1993 (56 FR 30266; 7/1/1991)

(f) EPA Maximum Contaminant Level Goals and National Primary Drinking Water Regulations for Lead and Copper, 40 CFR 141 and 142 (56 FR 26460; 6/7/91) effective 12/7/92.

(g) CDH/Colorado Water Quality Control Commission, Classifications and Water Quality Standards for Ground Water, 3.12.0 (9/19/1991).

**TABLE 3.2. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)**  
**FEDERAL SURFACE WATER QUALITY STANDARDS**

Parameter - CAS No.	Type (7) ug/l	PQL		Method (8) ug/l	SDWA Maximum Contaminant Levels (a) ug/l	SDWA Maximum Contaminant Levels (b) ug/l	SDWA Maximum Contaminant Level Goals (a) ug/l	SDWA Maximum Contaminant Level Goals (b) ug/l	CWA AWQC for Protection of		CWA AWQC for Protection of		NRC Effluent Standards Water pCi/L
		MDL RFP ug/l	CDH ug/l						Aquatic Life (c) Acute Value ug/l	Chronic Value ug/l	Human Health (c) Water and Fish Ingestion ug/l	Fish Consumption Only ug/l	
Bicarbonate	A	10,000		E310.1									
Carbonate	A	10,000		E310.1									
Chloride	A	5,000		E325	250,000*				860,000(e)	230,000(e)			
Chlorine 7782-50-5	A	1,000		E4500					19	11			
Fluoride	A	5,000		E340	4,000; 2,000*		4,000					4,000	
N as Nitrate	A	5,000		E353.1	10,000			10,000			10,000		
N as Nitrate+Nitrite	A	5,000		E353.1		10,000		10,000					
N as Nitrite	A	5,000		E354.1		1,000		1,000					
Sulfate	A	5,000		E375.4	250,000*								
Sulfide	A												
Coliform (Fecal)	B	1		SM9221C	1/100 ml								
Ammonia as N	C	5,000		E350					Criteria are pH and temperature dependent - see criteria document				
Dioxin 1746-01-6	D			d					0.01	0.00001	0.000000013	0.000000014	
Sulfur	E	100,000		E600									
Dissolved Oxygen (mg/l)	FP	500		SM4500					5,000				
pH	FP	0.1		E150.1	6.5-8.5 *					6.5-9			
Specific Conductance (uS/cm)	FP	1		E120.1									
Temperature	FP								SS	SS			
Boron	I	5,000		E6010									
Total Dissolved Solids	I	10,000		E160.1	500,000*				SS	SS	250,000		
Aluminum 7429-90-5	M	200		CT		50 to 200*			750	87			
Antimony 7440-36-0	M	50		CT					9,000	1,600	146	45,000	
Arsenic 7740-38-2	M	10		CT	50						0.0022	0.0175	
Arsenic III	M								360	190			
Arsenic V	M								850	48			
Barium 7440-39-3	M	200		CT	1,000	2,000 (f)		2,000 (f)			1,000		
Beryllium 7440-41-7	M	5		CT					130	5.3	0.068**	0.117**	
Cadmium 7440-43-9	M	5		CT	10	5		5	3.9 (3)	1.1 (3)	10		
Calcium 7440-70-2	M	5,000		E213.2									
Cesium 7440-46-2	M	1,000		NC									
Chromium 7440-47-3	M	10		E218.2	50	100		100					
Chromium III	M	5		SW8467196					1,700	210	170,000	3,433,000	
Chromium VI	M	10		E218.5					16	11	50		
Cobalt 7440-48-4	M	50		CT									
Copper 7440-50-8	M	25		E220.2	1,000*			1,300 (g)	18 (3)	12 (3)			
Cyanide -	M	10		E335.2					22	5.2	200		
Iron -	M	100		CT	300 *					1,000	300		
Lead 7439-92-1	M	5		E239.2	50			0 (g)	82 (3)	3.2 (3)	50		
Lithium 7439-93-2	M	100		NC									
Magnesium 7439-95-4	M	5000		CT									
Manganese 7439-96-5	M	15		CT	50 *						50	100	
Mercury 7439-97-6	M	0.2		CT	2	2		2	2.4	0.012	0.144	0.146	
Molybdenum 7439-93-7	M	200		NC									
Nickel 7440-02-0	M	40		CT					1,400 (3)	160 (3)	13.4	100	
Potassium 7440-09-7	M	5000		CT									
Selenium 7782-49-2	M	5		CT	10	50		50	20 (d)	5 (d)	10		
Silver 7440-22-4	M	10		E272.2	50	100 *			4.1 (3)	0.12	50		
Sodium 7440-23-5	M	5000		CT									
Strontium -	M	200		NC									
Thallium 7440-28-0	M	10		CT					1,400 (1)	40 (1)	13	48	

**TABLE 3.2. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)**  
**FEDERAL SURFACE WATER QUALITY STANDARDS**

Parameter - CAS No.	Type (7) ug/l	PQL		Method (8) ug/l	SDWA Maximum Contaminant Levels (a) ug/l	SDWA Maximum Contaminant Levels (b) ug/l	SDWA Maximum Contaminant Level Goals (a) ug/l	SDWA Maximum Contaminant Level Goals (b) ug/l	CWA AWQC for Protection of		CWA AWQC for Protection of		NRC Effluent Standards
		MDL ug/l	CDH ug/l						Aquatic Life (c)		Human Health (c) Water and Fish Ingestion ug/l	Fish Consumption Only ug/l	
									Acute Value ug/l	Chronic Value ug/l			Water pCVL
Tin 7440-31-5	M	200		NC									
Titanium 7440-32-6	M	10		E6010									
Tungsten 7440-33-7	M	10		E6010									
Vanadium 7440-62-2	M	50		CT									
Zinc 7440-66-6	M	20		CT	5,000 *				120 (3)	110 (3)			
2,4,5-TP Silvex	P		0.5	d	10	50		50					
2,4-Dichlorophenoxyacetic Acid (2,4-D) 94-75-7	P		1	d	100	70		70					
Acrolein 107-02-8	P		10						68(1)	21(1)	320	780	
Aldicarb 116-06-3	P		10			3 (1)		1 (1)					
Aldrin 309-00-2	P	0.05	0.1	E508					3.0		0.000074	0.000079	
Bromacil -	P												
Carbofuran 1563-66-2	P			d		40		40					
Chloramil -													
Chlordane (Alpha) 57-74-9	P	0.5	1	E508		2		0	2.4	0.0043	0.00046	0.00048	
Chlordane (Gamma) 57-74-9	P	0.5	1	E508		2		0	2.4	0.0043	0.00046	0.00048	
Chlorpyrifos	P		0.1	E619					0.063	0.041			
DDT 50-29-3	P	0.1	0.1	E508					1.1	0.0011	0.000024	0.000024	
DDT metabolite (DDD) -	P	0.1	0.1	CP					0.06				
DDT metabolite (DDE) -	P	0.1	0.1	CP					1.050				
Demeton 8065-48-3	P		1							0.1			
Diazinon 333-41-5	P												
Dieldrin 60-57-1	P	0.1	0.1	E508					2.5	0.0019	0.00007	0.000076	
Endosulfan I 959-95-2	P	0.05	0.1	CP					0.22	0.056	74	159	
Endosulfan II 33213-65-9	P	0.1	0.1	CP									
Endosulfan Sulfate 1031-07-8	P	0.1	0.1	CP									
Endrin 72-20-8	P	0.1	0.1	CP	0.2				0.18	0.0023	1		
Endrin Aldehyde 7421-93-4	P		0.1										
Endrin Ketone	P	0.1		CP									
Guthion 86-50-0	P		1.5							0.01			
Heptachlor 76-44-8	P	0.05	0.05	E508		0.4		0	0.52	0.0038	0.00028	0.00029	
Heptachlor Epoxide 1024-57-3	P	0.05	0.05	CP		0.2		0					
Hexachlorocyclohexane, Alpha 608-73-1	P	0.05	0.05	E508							0.0092	0.031	
Hexachlorocyclohexane, Beta 608-73-1	P	0.05	0.05	E505							0.0163	0.0547	
Hexachlorocyclohexane, BHC 608-73-1	P	0.05	0.05										
Hexachlorocyclohexane, Delta -608-73-1	P	0.05		CP									
Hexachlorocyclohexane, Technical 608-73-1	P		0.2	(E505/608)							0.0123	0.0414	
Hexachlorocyclohexane, (Lindane) Gamma 58-89-9	P	0.05	0.05	E505	4	0.2		0.2	2.0	0.08			
Malathion 121-75-5	P		0.2							0.01			
Methoxychlor 72-43-5	P	0.5	0.5	CP	100	40		40		0.03	100		
Mirex 2385-85-5	P		0.1							0.001			
Parathion 56-38-2	P								0.065	0.013			
PCBs 1336-36-3	P	0.5	1	E508		0.5		0	2.0	0.014	0.000079**	0.000079**	
Simazine -	P			(E608(1)/507(2))									
Toxaphene 8001-35-2	P	1	5	CP		3		0	0.73	0.0002	0.00071**	0.00073**	
Vaponite 2 -	P												
Aroclor 1016 12674-11-2	PP	0.5		CP									
Aroclor 1221 11104-28-2	PP	0.5		CP									

TABLE 3.2. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)  
FEDERAL SURFACE WATER QUALITY STANDARDS

Parameter - CAS No.	Type (7)	PQL		Method (8)	SDWA Maximum Contaminant Levels (a) ug/l	SDWA Maximum Contaminant Levels (b) ug/l	SDWA Maximum Contaminant Levels (c) ug/l	CWA		CWA AWQC for Protection of Human Health (c) ug/l	NRC Effluent Standards
		MDL RFP ug/l	CDH ug/l					Aquatic Life (c) Value ug/l	Chronic Value ug/l		
Aroclor 1232 11141-16-5	PP	0.5		CP							
Aroclor 1242 53469-21-9	PP	0.5		CP							
Aroclor 1248 12672-28-6	PP	0.5		CP							
Aroclor 1254 11097-68-1	PP	1		CP							
Aroclor 1260 11096-82-5	PP	1		CP							
Arazine 1912-24-9	PP			c(2)/507(3)		3					
Americium (pCi/l)	R										
Americium 241 (pCi/l)	R	0.01									
Cesium 134 (pCi/l)	R	1									
Cesium 137 (pCi/l)	R	1									
Gross Alpha (pCi/l)	R	2			15 (10)						
Gross Beta (pCi/l)	R	4			50 (4 mrem/yr)						
Plutonium (pCi/l)	R										
Plutonium 238+239+240 (pCi/l)	R	0.01									
Radium 226+228 (pCi/l)	R	0.5/0.1 (9)									
Strontium 89+90 (pCi/l)	R	1									
Strontium 90 (pCi/l)	R										
Thorium 230+232 (pCi/l)	R				8 (6)						
Tritium (pCi/l)	R				20,000 (6)						
Uranium 233+234 (pCi/l)	R										
Uranium 235 (pCi/l)	R	0.6									
Uranium 238 (pCi/l)	R	0.6									
Uranium (total) (pCi/l)	R										
1,2,4,5-Tetrachlorobenzene 95-94-3	SV			b							
1,2,4-Trichlorobenzene	SV	10		CS							
1,2-Dichlorobenzene (Ortho) 95-50-1	SV	10		CS							
1,2-Diphenylhydrazine 122-66-7	SV			b							
1,3-Dichlorobenzene (Meta) 541-73-1	SV	10		CS							
1,4-Dichlorobenzene (Para) 106-46-7	SV	10		CS							
2,4,5-Trichlorophenol 95-95-5	SV	50		CS	75						
2,4,6-Trichlorophenol 88-06-2	SV	10		ES02.2							
2,4-Dichlorophenol 120-83-2	SV	10		CS							
2,4-Dimethylphenol 105-67-9	SV	10		CS							
2,4-Dinitrophenol 51-28-5	SV	50		CS							
2,4-Dinitrobenzene 25321-14-6	SV	10		CS							
2,6-Dinitrobenzene 25321-14-6	SV	10		CS							
2-Chloronaphthalene 91-58-7	SV	10		CS							
2-Chlorophenol 95-57-8	SV	10		CS							
2-Methylnaphthalene 1321-94-4	SV	10		CS							
2-Methylphenol 1319-77-3	SV	10		CS							
2-Nitroaniline 100-01-6	SV	50		CS							
2-Nitrophenol 88-75-5	SV	10		CS							
3,3-Dichlorobenzidine 91-94-1	SV	20		ES625							
3-Nitroaniline 100-01-6	SV	50		CS							
4,6-Dinitro-2-methylphenol -	SV	50		CS							
4-Bromophenyl Phenylether 101-55-3	SV	10		CS							
4-Chloroaniline -	SV	10		CS							
4-Chlorophenyl Phenyl Ether 7005-72-3	SV	10		CS							
4-Chloro-3-methylphenol	SV	10		CS							
4-Methylphenol	SV	10		CS							

TABLE 3.2. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)  
FEDERAL SURFACE WATER QUALITY STANDARDS

Parameter - CAS No.	Type (7)	PQL		Method (8)	SDWA Maximum Contaminant Levels (a) ug/l	SDWA Maximum Contaminant Levels (b) ug/l	SDWA Maximum Contaminant Level Goals (a) ug/l	SDWA Maximum Contaminant Level Goals (b) ug/l	CWA		CWA AWQC for Protection of Human Health (c) ug/l	NRC Effluent Standards Water pC/L
		MDL RFP ug/l	CDH ug/l						Aquatic Life (c) Acute Value ug/l	Chronic Value ug/l		
4-Nitroaniline 100-01-6	SV	50		CS					230 (1)	150 (1)		
4-Nitrophenol 100-02-7	SV	50		CS					1,700 (1)	520 (1)		
Acenaphthene 83-32-9	SV	10	10	CS								
Anthracene 120-12-7	SV	10	1	CS								
Benidine 92-87-5	SV	10	1	d,B625								
Benzoic Acid 65-85-0	SV	50		CS					2,500		0.00012	
Benzo(a)anthracene 56-55-3	SV	10	10	CS								
Benzo(a)pyrene 50-32-8	SV	10	10	CS								
Benzo(b)fluoranthene 205-99-2	SV	10	10	CS								
Benzo(g,h,i)perylene 191-24-2	SV	10	10	CS								
Benzo(k)fluoranthene 207-09-9	SV	10	10	CS								
Benzyl Alcohol 100-51-6	SV	10		CS								
bis(2-Chloroethoxy)methane -	SV	10	10	CS								
bis(2-Chloroethoxy)ether 111-44-4	SV	10	10	B625								
bis(2-Chloroisopropyl)ether -	SV	10	10	CS								
bis(2-Ethylhexyl)phthalate -	SV	10	10	CS								
Butadiene 106-99-0	SV	10		CS								
Butylbenzylphthalate -	SV	10		CS								
Chlorinated Ethers -	SV											
Chlorinated Naphthalenes -	SV											
Chloroalkyl ethers -	SV											
Chlorophenol -	SV	10		CS					1,600 (1)			
Chrysene 218-01-9	SV	10	50	CS					238,000 (1)			
Dibenzofuran 132-64-9	SV	10	10	CS								
Dibenz(a,h)anthracene 53-70-3	SV	10	10	CS								
Dichlorobenzenes 95-50-1	SV	10	1	CS								
Dichlorobenzidine 91-94-1	SV	20	10	B625					1,120 (1)	763 (1)		
Diethylphthalate -	SV	10	10	CS								
Dimethylphthalate -	SV	10	10	CS								
Di-n-butylphthalate -	SV	10	10	CS								
Di-n-octylphthalate -	SV	10	10	CS								
Ethylene Glycol 107-21-1	SV	10		d					3,980 (1)			
Fluoranthene 206-44-0	SV	10	10	CS								
Fluorene 86-73-7	SV	10	10	CS								
Formaldehyde 50-00-0	SV											
Halobenzene -	SV											
Hexachlorobenzene 118-74-1	SV	10	10	B525					380 (1)	122 (1)		
Hexachlorobutadiene 87-68-3	SV	10	10	B525					90 (1)	93 (1)		
Hexachlorocyclopentadiene 77-47-4	SV	10	10	CS					7 (1)	5.2 (1)		
Hexachloroethane	SV	10	10	B525					980 (1)	540 (1)		
Hydrazine 302-01-2	SV	10	10	CS								
Indeno[1,2,3-c]pyrene	SV	10	10	CS					117,000 (1)			
Isophorone 78-59-1	SV	10	10	CS					2,300 (1)			
Naphthalene 91-20-3	SV	10	10	CS					27,000 (1)			
Nitrobenzene 98-95-3	SV	10	10	CS					230 (1)	150 (1)		
Nitrobenzols -	SV								5,850 (1)			
Nitrobenzyl -	SV											
Nitrobenzylamine 924-16-3	SV	10	10	b,B607								
Nitrodiethylamine 55-18-5	SV	10	10	b,B607								
Nitrodimethylamine 62-75-9	SV	10	10	b,B607								
Nitropropylamine 930-55-2	SV	10	10	b,B625								
N-Nitrosodiphenylamine 86-30-6	SV	10	10	b,B607								

TABLE 3.2. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)

Parameter - CAS No.	Type (7)	RFP MDL CDH	Method (8)	SDWA Maximum Contaminant Level (a) ug/l	SDWA Maximum Contaminant Level (b) ug/l	SDWA Maximum Contaminant Level (a) ug/l	SDWA Maximum Contaminant Level (b) ug/l	CWA AWQC for Protection of Aquatic Life (c) ug/l	CWA AWQC for Protection of Chronic Value ug/l	CWA AWQC for Protection of Human Health (c) Fish Consumption ug/l	PCVL Water	NRC Effluent Standards
N-Nitroso-d-n-propylamine -	SV	10	b	10	b	10	b	1,100 (1)	7,240 (1)	1,010	74	85
Pentachlorinated Ethanes -	SV	10	b	10	b	10	b	1,100 (1)	7,240 (1)	1,010	74	85
Pentachlorobenzene 608-93-5	SV	50	CS	50	CS	50	CS	13 (4)	20 (4)	1,010	74	85
Pentachlorophenol 87-86-5	SV	50	CS	50	CS	50	CS	13 (4)	20 (4)	1,010	74	85
Phenanthrene 85-01-8	SV	10	CS	10	CS	10	CS	13 (4)	20 (4)	1,010	74	85
Phenol 108-95-2	SV	10	CS	10	CS	10	CS	13 (4)	20 (4)	1,010	74	85
Polynuclear Aromatic Hydrocarbons	SV	10	CS	10	CS	10	CS	13 (4)	20 (4)	1,010	74	85
Vinyl Chloride 75-01-4	SV	10	b, E610	10	b, E610	10	b, E610	13 (4)	20 (4)	1,010	74	85
1,1,1-Trichloroethane 71-55-6	V	5	1	1	1	1	1	13 (4)	20 (4)	1,010	74	85
1,1,2,2-Tetrachloroethane 79-34-5	V	5	1	1	1	1	1	13 (4)	20 (4)	1,010	74	85
1,1,2-Trichloroethane 79-00-5	V	5	1	1	1	1	1	13 (4)	20 (4)	1,010	74	85
1,1-Dichloroethane 75-34-3	V	5	1	1	1	1	1	13 (4)	20 (4)	1,010	74	85
1,2-Dichloroethane 107-06-2	V	5	1	1	1	1	1	13 (4)	20 (4)	1,010	74	85
1,2-Dichloroethane (cis) -	V	5	1	1	1	1	1	13 (4)	20 (4)	1,010	74	85
1,2-Dichloroethane (trans) -	V	5	1	1	1	1	1	13 (4)	20 (4)	1,010	74	85
1,2-Dichloropropane 78-87-5	V	5	1	1	1	1	1	13 (4)	20 (4)	1,010	74	85
1,3-Dichloropropane (cis) 542-75-6	V	5	1	1	1	1	1	13 (4)	20 (4)	1,010	74	85
1,3-Dichloropropane (trans) 542-75-6	V	5	1	1	1	1	1	13 (4)	20 (4)	1,010	74	85
2-Bromonitrobenzene 78-93-3	V	10	1	10	1	10	1	13 (4)	20 (4)	1,010	74	85
2-Hexanone 591-78-6	V	10	1	10	1	10	1	13 (4)	20 (4)	1,010	74	85
4-Methyl-2-pentanone 108-10-1	V	10	1	10	1	10	1	13 (4)	20 (4)	1,010	74	85
Acetone 67-64-1	V	10	1	10	1	10	1	13 (4)	20 (4)	1,010	74	85
Acrylonitrile 107-13-1	V	5	1	5	1	5	1	13 (4)	20 (4)	1,010	74	85
Benzene 71-43-2	V	5	1	5	1	5	1	13 (4)	20 (4)	1,010	74	85
Bromodichloroethane 75-27-4	V	5	1	5	1	5	1	13 (4)	20 (4)	1,010	74	85
Bromonitrobenzene 75-25-2	V	5	1	5	1	5	1	13 (4)	20 (4)	1,010	74	85
Bromonitrobenzene 74-83-9	V	5	1	5	1	5	1	13 (4)	20 (4)	1,010	74	85
Carbon Disulfide 75-15-0	V	5	1	5	1	5	1	13 (4)	20 (4)	1,010	74	85
Carbon Tetrachloride 56-23-5	V	5	1	5	1	5	1	13 (4)	20 (4)	1,010	74	85
Chlorinated Benzenes -	V	10	1	10	1	10	1	13 (4)	20 (4)	1,010	74	85
Chlorobenzene 108-90-7	V	5	1	5	1	5	1	13 (4)	20 (4)	1,010	74	85
Chlorobenzene 75-00-3	V	10	1	10	1	10	1	13 (4)	20 (4)	1,010	74	85
Chlorobenzene 67-66-3	V	5	1	5	1	5	1	13 (4)	20 (4)	1,010	74	85
Chlorobenzene 74-87-3	V	10	1	10	1	10	1	13 (4)	20 (4)	1,010	74	85
Dichlorobenzene -	V	5	1	5	1	5	1	13 (4)	20 (4)	1,010	74	85
Dibromochloroethane -	V	5	1	5	1	5	1	13 (4)	20 (4)	1,010	74	85
Dibromobenzene 100-41-4	V	5	1	5	1	5	1	13 (4)	20 (4)	1,010	74	85
Ethylene Dichloride 106-43-4	V	5	1	5	1	5	1	13 (4)	20 (4)	1,010	74	85
Ethylene Oxide 75-21-8	V	5	1	5	1	5	1	13 (4)	20 (4)	1,010	74	85
Halobenzenes	V	5	1	5	1	5	1	13 (4)	20 (4)	1,010	74	85
Methylene Chloride 75-09-2	V	5	1	5	1	5	1	13 (4)	20 (4)	1,010	74	85
Pyrene 129-00-0	V	10	10	10	10	10	10	13 (4)	20 (4)	1,010	74	85
Styrene 100-42-5	V	5	1	5	1	5	1	13 (4)	20 (4)	1,010	74	85
Tetrachloroethanes 79-34-5	V	5	1	5	1	5	1	13 (4)	20 (4)	1,010	74	85
Tetrachloroethane -	V	5	1	5	1	5	1	13 (4)	20 (4)	1,010	74	85
Toluene 108-88-3	V	5	1	5	1	5	1	13 (4)	20 (4)	1,010	74	85
Trichloroethanes 79-00-5	V	5	1	5	1	5	1	13 (4)	20 (4)	1,010	74	85
Trichloroethylene 79-01-6	V	5	1	5	1	5	1	13 (4)	20 (4)	1,010	74	85

**TABLE 3.2. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)  
FEDERAL SURFACE WATER QUALITY STANDARDS**

Parameter - CAS No.	Type (7) ug/l	PQL		Method (8) ug/l	SDWA Maximum Contaminant Levels (a) ug/l	SDWA Maximum Contaminant Levels (b) ug/l	SDWA Maximum Contaminant Level Goals (a) ug/l	SDWA Maximum Contaminant Level Goals (b) ug/l	CWA AWQC for Protection of		CWA AWQC for Protection of		NRC Effluent Standards
		MDL	CDH						Aquatic Life (c) Acute Value ug/l	Chronic Value ug/l	Human Health (c) Water and Fish Ingestion ug/l	Fish Consumption Only ug/l	
Vinyl Acetate 75-01-4	V	10		CV									
Xylenes (total) 1330-20-7	V	5		CV		10,000		10,000					

**EXPLANATION OF TABLE**

\* = secondary maximum contaminant level

\*\* = Human health criteria for carcinogens reported for three risk levels. Value presented is the 10-5 risk level.

AWQC	= Ambient Water Quality Criteria
CLP	= Contract Laboratory Program
CWA	= Clean Water Act
EPA	= Environmental Protection Agency
pCi/l	= picocuries per liter
PCB	= polychlorinated biphenyl
PQL	= Practical Quantitation Level
SDWA	= Safe Drinking Water Act
SS	= Species Specific
TAL	= Target Analyte List
THM	= Total Trihalomethanes
TIC	= Tentatively Identified Compound
MDL	= Minimum Detection Limit for radionuclides (pCi/l)
ug/l	= micrograms per liter
VOA	= Volatile Organic Analysis

(1) criteria not developed; value presented is lowest observed effects level (LOEL)

(2) total trihalomethanes: chloroform, bromoform, bromodichloromethane, dibromochloromethane

(3) hardness dependent criteria

(4) pH dependent criteria (7.8 pH used)

(5) standard is not adequately protective when chloride is associated with potassium, calcium, or magnesium, rather than sodium.

(6) if both strontium-90 and tritium are present, the sum of their annual dose equivalents to bone marrow shall not exceed 4 mrem/yr.

(7) type abbreviations are: A=anion; B=bacteria; C=cation; D=dioxin; E=element; I=indicator; FP=field parameter; M=metal; P=pesticide; PP=pesticide/PCB;

R=radionuclide; SV=semi-volatile; V=volatile

(8) method abbreviations are: CT=CLP-TAL; NC=non-CLP; CV=CLP-VOA; CS=CLP-SEMI; EP=EPA-PEST; CP=CLP-PEST; E=EPA; a = detected as total in CV; b = detected as TIC in CS;

c = detected as TIC in CV; d = not routinely monitored; e = monitored in discharge ponds; f = mixture-individual isomers detected.

(9) MDL for radium 226 is 0.5; MDL for radium 228 is 1.0

(10) Value for gross alpha excludes uranium

(a) EPA National Primary and Secondary Drinking Water Regulations, 40 CFR 141 and 40 CFR 143 (as of May 1990).

(b) EPA National Primary and Secondary Drinking Water Regulations, 40 CFR Parts 141, 142 and 143, Final Rule, effective July 30, 1992 (56 Federal Register 3526; 1/30/1991).

(c) EPA, Quality Criteria for Protection of Aquatic Life, 1986

(d) EPA, National Ambient Water Quality Criteria for Selenium - 1987

(e) EPA, National Ambient Water Quality Criteria for Chloride - 1988

(f) EPA National Primary and Secondary Drinking Water Regulations, 40 CFR Parts 141, 142, and 143, Final Rule (56 FR 30266; 7/1/1991) effective 1/1/1993.

(g) EPA Maximum Contaminant Level Goals and National Primary Drinking Water Regulations for Lead and Copper, 40 CFR 141 and 142 (56 FR 26460; 6/7/1991) effective 12/7/91.

(h) NRC Effluent Water Concentrations - 10 CFR 20 Appendix A, Table 2, Column 2 "Effluent Concentrations for Water" (56 FR 23412 - 23464, May 21, 1991) effective 6/20/91.

**TABLE 3.3. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)  
STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS**

Statewide Standards (a)														Basin Standards (b)	
Parameter - CAS No.	Type (5)	PQL MDL		Method (6)	Human Health Carcinogens/ Noncarcinogens (2) (5)		Aquatic Life (8)		Tables I,II,III (1)				Organics (7)		
		RFP ug/l	CDH ug/l		Water Supply ug/l	Water and Fish ug/l	Acute Value ug/l	Chronic Value ug/l	Acute Value (2) ug/l	Chronic Value (2) ug/l	Agricul- tural Standard (3) ug/l	Domestic Water Supply (4) ug/l	Aquatic Life ug/l	Water Supply ug/l	
Bicarbonate	A	10,000													
Carbonate	A	10,000		E310.1											
Chloride	A	5,000		E325								250,000			
Chlorine	A	1,000		E4500					19	11					
Fluoride	A	5,000		E340								2,000			
N as Nitrate	A	5,000		E353.1							100,000	10,000			
N as Nitrate+Nitrite	A	5,000		E353.1							100,000	10,000			
N as Nitrite	A	5,000		E354.1					SS	SS	10,000	1,000			
Sulfate	A	5,000		E375.4								250,000			
Sulfide	A									2		50			
Coliform (Fecal)	B	1		SM9221C								2000/100 ml			
Ammonia as N	C	5,000		E350					620	60		500			
Dioxin 1746-01-6	D			d	0.00000022	0.00000013	0.01	0.00001							
Sulfur	E	100,000		E600											
Dissolved Oxygen (mg/l)	FP	500		SM4500					5,000	5,000	3,000	3,000			
pH	FP	0.1		E150.1					6.5-9.0	6.5-9.0		5.0-9.0			
Specific Conductance (uS/cm)	FP	1		E120.1											
Temperature	FP								30 degrees	30 degrees					
Boron	I	5,000		E6010							750				
Total Dissolved Solids	I	10,000		E160.1											
Aluminum 7429-90-5	M	200		CT					750	87					
Antimony 7440-36-0	M	50		CT								14			
Arsenic 7740-38-2	M	10		CT					360	150	100	50			
Arsenic III -	M														
Arsenic V -	M														
Barium 7440-39-3	M	200		CT								1,000			
Beryllium 7440-41-7	M	5		CT							100	0.0076			
Cadmium 7440-43-9	M	5		E213.2					TVS	TVS	10	10			
Calcium 7440-70-2	M	5,000		CT											
Cesium 7440-46-2	M	1,000		NC											
Chromium 7440-47-3	M	10		E218.2											
Chromium III	M	5		SW8467196					TVS	TVS	100	50			
Chromium VI	M	10		E218.5					16	11	100	50			
Cobalt 7440-48-4	M	50		CT											
Copper 7440-50-8	M	25		E220.2					TVS	TVS	200	1,000			
Cyanide	M	10		E335.2					5	5	200	200			
Iron	M	100		CT						1,000		300 (dis)			
Lead 7439-92-1	M	5		E239.2					TVS	TVS	100	50			
Lithium 7439-93-2	M	100		NC											
Magnesium 7439-95-4	M	5000		CT											
Manganese 7439-96-5	M	15		CT						1,000	200	50 (dis)			
Mercury 7439-97-6	M	0.2		CT					2.4	0.1		2.0			
Molybdenum 7439-93-7	M	200		NC											
Nickel 7440-02-0	M	40		CT					TVS	TVS	200				
Potassium	M	5000		CT											
Selenium 7782-49-2	M	5		CT					135	17	20	10			
Silver 7440-22-4	M	10		E272.2					TVS	TVS		50			
Sodium 7440-23-5	M	5000		CT											
Strontium -	M	200		NC											
Thallium 7440-28-0	M	10		CT						15		0.012			



**TABLE 3.3. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)  
STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS**

Statewide Standards (a)													Basin Standards (b)		
Parameter - CAS No.	Type (5)	PQL MDL		Method (6)	Human Health Carcinogens/ Noncarcinogens (2) (5)		Aquatic Life (5)		Tables I,II,III (1)				Organics (7)		
		RFP ug/l	CDH ug/l		Water Supply ug/l	Water and Fish ug/l	Acute Value ug/l	Chronic Value ug/l	Aquatic Life		Agricultural Standard (3) ug/l	Domestic Water Supply (4) ug/l	Aquatic Life ug/l	Water Supply ug/l	
									Acute Value (2) ug/l	Chronic Value (2) ug/l					
Tin 7440-31-5	M	200		NC											
Titanium 7440-32-6	M	10		E6010											
Tungsten 7440-33-7	M	10		E6010											
Vanadium 7440-62-2	M	50		CT											
Zinc 7440-66-6	M	20		CT					TVS	TVS	2,000	5,000			
2,4,5-TP Silvex	P		0.5	d	50										
2,4-Dichlorophenoxyacetic Acid (2,4-D) 94-75-7	P		1	d	70										100
Acrolein 107-02-8			10			320	68	21							
Aldicarb 116-06-3	P		10		10										
Aldrin 309-00-2	P	0.05	0.1	E508	0.002 (8)	0.00013	1.5							0.003	
Bromacil -	P														
Carbofuran 1563-66-2	P			d	36										
Chloranil -	P			E619											
Chlordane (Alpha) 57-74-9	P	0.5	1	CP	0.03 (8)		1.2	0.0043							
Chlordane (Gamma) 57-74-9	P	0.5	1	CP	0.03 (8)	0.00058	1.2	0.0043							
Chlorpyrifos 2921-88-2	P		0.1				0.083								
DDT 50-29-3	P	0.1	0.1	E508	0.1	0.00059	0.55	0.001						0.001	
DDT Metabolite (DDD) -	P	0.1	0.1	CP		0.0008	0.6							0.001	
DDT Metabolite (DDE) -	P	0.1	0.1	CP	0.1	0.00059	1.050							0.001	
Demeton 8065-48-3	P		1					0.1						0.1	
Diazinon 333-41-5	P														
Dieldrin 60-57-1	P	0.1	0.1	E508	0.002	0.00014	1.3	0.0019						0.003	
Endosulfan I 959-95-8	P	0.05	0.1	CP		0.93	0.11	0.056						0.003	
Endosulfan II 33213-65-9	P	0.1	0.1	CP											
Endosulfan Sulfate 1031-07-8	P	0.1	0.1	CP		0.93									
Endrin 72-20-8	P	0.1	0.1	CP	0.2		0.09	0.0023						0.004	
Endrin Aldehyde 7421-93-4	P		0.1		0.2	0.2									
Endrin Ketone	P	0.1		CP											
Guthion 86-50-0	P		1.5					0.01						0.01	
Heptachlor 76-44-8	P	0.05	0.05	E508	0.008	0.00021	0.26	0.0038						0.001	0.2
Heptachlor Epoxide 1024-57-3	P	0.05	0.05	CP	0.09	0.0001	0.26	0.0038							
Hexachlorocyclohexane, Alpha 608-73-1	P	0.05	0.05	E505	0.006		0.0039								
Hexachlorocyclohexane, Beta 608-73-1	P	0.05	0.05	E505		0.014									
Hexachlorocyclohexane, BHC 608-73-1	P	0.05	0.05				100								
Hexachlorocyclohexane, Delta 608-73-1	P	0.05		CP											
Hexachlorocyclohexane, Tech. 608-73-1	P		0.2			0.012									
Hexachlorocyclohexane, Lindane 58-89-9	P	0.05	0.05	E505	0.2	0.019	1.0	0.08						0.01	4.0
Malathion 121-75-5	P		0.2					0.1						0.1	
Methoxychlor 72-43-5	P	0.5	0.5	CP	40			0.03						0.03	100
Mirex 2385-85-5	P		0.1					0.001						0.001	
Parathion 56-38-2	P													0.04	
PCBs 1336-36-3	P	0.5	1	E508	0.005	0.000044	2.0	0.014						0.001	
Simazine -	P			E608(1)/ 507(2)											
Toxaphene 8001-35-2	P	1	5	CP	0.03	0.00073	0.73	0.0002						0.005	5.0
Vaponite 2 -	P														
Aroclor 1016 12674-11-2	PP	0.5		CP											
Aroclor 1221 11104-28-2	PP	0.5		CP											
Aroclor 1232 11141-16-5	PP	0.5		CP											
Aroclor 1242 53469-21-9	PP	0.5		CP											
Aroclor 1248 12672-29-6	PP	0.5		CP											

**TABLE 3.3. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)  
STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS**

Statewide Standards (a)														Basin Standards (b)	
Parameter - CAS No.	Type (5)	PQL MDL		Method (6)	Human Health Carcinogens/ Noncarcinogens (2) (8)		Aquatic Life (8)		Tables I,II,III (1)				Organics (7)		
		RFP ug/l	CDH ug/l		Water Supply ug/l	Water and Fish ug/l	Acute Value ug/l	Chronic Value ug/l	Aquatic Life		Agricultural Standard (3) ug/l	Domestic Water Supply (4) ug/l	Aquatic Life ug/l	Water Supply ug/l	
									Acute Value (2) ug/l	Chronic Value (2) ug/l					
Aroclor 1254 11097-69-1	PP	1		CP											
Aroclor 1260 11096-82-5	PP	1		CP											
Atrazine 1912-24-9	PP			E608(2)/ 507(3)											
Americium (pCi/l)	R														
Americium 241 (pCi/l)	R	0.01													
Cesium 134 (pCi/l)	R	1			80 (10)										
Cesium 137 (pCi/l)	R	1													
Gross Alpha (pCi/l)	R	2													
Gross Beta (pCi/l)	R	4													
Plutonium (pCi/l)	R														
Plutonium 238+239+240 (pCi/l)	R	0.01			15 (10)										
Radium 226+228 (pCi/l)	R	0.5/l (9)			5 (10)										
Strontium 89+90 (pCi/l)	R	1													
Strontium 90 (pCi/l)	R				8 (10)										
Thorium 230+232 (pCi/l)	R				60 (10)										
Tritium (pCi/l)	R				20,000 (10)										
Uranium 233+234 (pCi/l)	R														
Uranium 235 (pCi/l)	R	0.6													
Uranium 238 (pCi/l)	R	0.6													
Uranium (Total) (pCi/l)	R								TVS	TVS					
1,2,4,5-Tetrachlorobenzene 95-94-3	SV		10	CS	2 (8)										
1,2,4-Trichlorobenzene	SV	10		CS											
1,2-Dichlorobenzene (Ortho) 95-50-1	SV	10	1	CS	620	620									
1,2-Diphenylhydrazine 122-66-7	SV			CS	0.05	0.04	270								
1,3-Dichlorobenzene (Meta) 541-73-1	SV	10	1	CS	620	400									
1,4-Dichlorobenzene (Para) 106-46-7	SV	10	1	CS	75	75									
2,4,5-Trichlorophenol 95-95-5	SV	50		CS											
2,4,6-Trichlorophenol 88-06-2	SV	10	50	E502.2	2	2		970							
2,4-Dichlorophenol 120-83-2	SV	10	50	CS	21	21	2,020	365							
2,4-Dimethylphenol 105-67-9	SV	10	50	CS			2,120								
2,4-Dinitrophenol 51-28-5	SV	50	50	CS	14	14									
2,4-Dinitrotoluene 25321-14-6	SV	10	10	CS		0.11									
2,6-Dinitrotoluene 25321-14-6	SV	10	10	CS			330	230							
2-Chloronaphthalene 91-58-7	SV	10		CS											
2-Chlorophenol 95-57-8	SV	10	50	CS			4,380	2,000							
2-Methylnaphthalene 1321-94-4	SV	10		CS											
2-Methylphenol 1319-77-3	SV	10		CS											
2-Nitroaniline 100-01-6	SV	50		CS											
2-Nitrophenol 88-75-5	SV	10		CS											
3,3-Dichlorobenzidine 91-94-1	SV	20	10	E625		0.039									
3-Nitroaniline 100-01-6	SV	50		CS											
4,6-Dinitro-2-methylphenol -	SV	50	50	CS		13									
4-Bromophenyl Phenylether 105-55-3	SV	10		CS											
4-Chloroaniline -	SV	10		CS											
4-Chlorophenyl Phenyl Ether 7005-72-3	SV	10		CS											
4-Chloro-3-methylphenol	SV	10	50	CS			30								
4-Methylphenol -	SV	10		CS											
4-Nitroaniline 100-01-6	SV	50		CS											
4-Nitrophenol 100-02-7	SV	50		CS											
Acenaphthene 83-32-9	SV	10	10	CS			1,700	520							

TABLE 3.3. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)  
STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS

Statewide Standards (a)													Basin Standards (b)		
Parameter - CAS No.	Type (5)	FQL		Method (6)	Human Health Cardiogenic/ Neurocarcinogens		Aquatic Life (8)		Tables I, II, III (1)			Domestic Water Supply (4) ug/l	Organics (7)		
		RFP ug/l	CDH ug/l		(2) (8)	Water Supply ug/l	Water and Fish ug/l	Acute Value ug/l	Chronic Value ug/l	Aquatic Life			Agricultural Standard (3) ug/l	Aquatic Life ug/l	Water Supply ug/l
										Acute Value ug/l	Chronic Value ug/l				
Anthrone 120-12-7	SV	10	1	CS	0.0002	0.0028	2,500					0.1	0.01		
Benzo(a)pyrene 92-87-5	SV	50	10	CS	0.0002	0.00012(8)									
Benzoic Acid 65-85-0	SV	10	10	CS		0.0028									
Benzo(a)anthracene 56-55-3	SV	10	10	CS		0.0028									
Benzo(a)pyrene 50-32-8	SV	10	10	CS		0.0028									
Benzo(b)fluoranthene 205-99-2	SV	10	10	CS		0.0028									
Benzo(g,h,i)perylene 50-32-8	SV	10	10	CS		0.0028									
Benzo(k)fluoranthene 205-99-2	SV	10	10	CS		0.0028									
Benzo(l)fluoranthene 205-99-2	SV	10	10	CS		0.0028									
Benzyl Alcohol 100-51-6	SV	10	10	CS		0.03 (8)									
bis(2-Chloroethoxy)methane	SV	10	10	CS		0.03 (8)									
bis(2-Chloroethyl)ether 111-44-4	SV	10	10	CS		1,400									
bis(2-Chloroisopropyl)ether	SV	10	10	CS		1.8 (8)									
bis(2-Ethylhexyl)phthalate	SV	10	10	CS		3,000									
Butadiene 106-99-0	SV	10	10	CS											
Butyl Benzylphthalate	SV	10	10	CS											
Chlorinated Ethers	SV	10	10	CS											
Chlorinated Naphthalenes	SV	10	10	CS											
Chloroalkyl ethers	SV	10	10	CS											
Chlorophenol	SV	10	10	CS											
Chrysene 218-01-9	SV	10	10	CS		0.0028									
Dibenzofuran 132-64-9	SV	10	10	CS		0.0028									
Dibenz(a,h)anthracene 53-70-3	SV	10	10	CS											
Dichlorobenzene 95-50-01	SV	20	10	CS		0.039									
Dichlorobenzidine 91-94-1	SV	10	10	CS		23,000									
Diethylphthalate	SV	10	10	CS		313,000									
Dimethylphthalate	SV	10	10	CS		2,700									
Di-n-butylphthalate	SV	10	10	CS											
Di-n-octylphthalate	SV	10	10	CS											
Ethylene Glycol 107-21-1	SV	10	10	CS		42									
Fluoranthene 206-44-0	SV	10	10	CS		0.0028									
Fluorene 86-73-7	SV	10	10	CS											
Formaldehyde 50-00-0	SV	10	10	CS											
Haloethers	SV	10	10	CS											
Hexachlorobenzene 118-74-1	SV	10	10	CS		0.00072									
Hexachlorobutadiene 87-68-3	SV	10	10	CS		0.45									
Hexachlorocyclopentadiene 77-47-4	SV	10	10	CS		240									
Hexachloroethane	SV	10	10	CS		1.9									
Hydrazine 302-01-2	SV	10	10	CS		0.0028									
Indeno(1,2,3-cd)pyrene	SV	10	10	CS		8.4									
Isophthalene 78-59-1	SV	10	10	CS		0.0028									
Naphthalene 91-20-3	SV	10	10	CS		3.5									
Nitrobenzene 98-95-3	SV	10	10	CS											
Nitrophenols	SV	10	10	CS											
Nitrosamines	SV	10	10	CS		0.0064									
Nitrosodibutylamine 924-16-3	SV	10	10	CS		0.0008									
Nitrosodimethylamine 55-18-5	SV	10	10	CS		0.00069									
Nitrosodimethylamine 62-75-9	SV	10	10	CS		0.016									
Nitrosopyrrolidine 930-55-2	SV	10	10	CS		4.9									
N-Nitrosodiphenylamine 86-30-6	SV	10	10	CS		0.005									
N-Nitroso-di-n-propylamine	SV	10	10	CS											
Pentachlorinated Ethanes	SV	10	10	CS											
Pentachlorobenzene 608-93-5	SV	50	50	CS		6 (8)									
Pentachlorophenol 87-86-5	SV	50	50	CS		200									
	SV	50	50	CS											
	SV	50	50	CS											
	SV	50	50	CS											
	SV	50	50	CS											
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	SV	50	50	CS											
	SV	50	50	CS											
	SV	50	50	CS											

**TABLE 3.3. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)  
STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS**

Statewide Standards (a)													Basin Standards (b)		
Parameter - CAS No.	Type (5)	PQL MDL		Method (6)	Human Health Carcinogens/ Noncarcinogens (2) (5)		Aquatic Life (8)		Tables I,II,III (1)				Organics (7)		
		RFP ug/l	CDH ug/l		Water Supply ug/l	Water and Fish ug/l	Acute Value ug/l	Chronic Value ug/l	Aquatic Life		Agricultural Standard (3) ug/l	Domestic Water Supply (4) ug/l	Aquatic Life ug/l	Water Supply ug/l	
									Acute Value (2) ug/l	Chronic Value (2) ug/l					
Phenanthrene 85-01-8	SV	10	10	CS		0.0028									
Phenol 108-95-2	SV	10	50	CS		21,000	10,200	2,560						500	1.0
Phthalate Esters -	SV			e											
Polynuclear Aromatic Hydrocarbons -	SV		10	b,E610		0.0028									
Vinyl Chloride 75-01-4	SV	10	2	CV	2	2									
1,1,1-Trichloroethane 71-55-6	V	5	1	CV	200	200									
1,1,2,2-Tetrachloroethane 79-34-5	V	5	1	E502.2		0.17		2,400							
1,1,2-Trichloroethane 79-00-5	V	5	1	E502.2	3	0.6	9,400								
1,1-Dichloroethane 75-34-3	V	5		CV											
1,1-Dichloroethene -	V	5	1	CV	7	0.057									
1,2-Dichloroethane 107-06-2	V	5	1	CV	0.4	0.4	118,000	20,000							
1,2-Dichloroethene (cis) -	V		1	a	70										
1,2-Dichloroethene (total) -	V	5		CV											
1,2-Dichloroethene (trans) -	V	5	1	a	100										
1,2-Dichloropropane 78-87-5	V	5	1	CV	0.56 (8)	0.56	23,000	5,700							
1,3-Dichloropropene (cis) 542-75-6	V	5	1	CV		10	6,060	244							
1,3-Dichloropropene (trans) 542-75-6	V	5	1	CV		10	6,060	244							
2-Butanone 78-93-3	V	10		CV											
2-Hexanone 591-78-6	V	10		CV											
4-Methyl-2-pentanone 108-10-1	V	10		CV											
Acetone 67-64-1	V	10		CV											
Acrylonitrile 107-13-1	V		5	c,E625		0.58	7,550	2,600							
Benzene 71-43-2	V	5	1	CV	1	1	5,300								
Bromodichloromethane 75-27-4	V	5	1	CV	0.3	0.3									
Bromoform 75-25-2	V	5	1	CV	4	4									
Bromomethane 74-83-9	V	10	1	CV		48									
Carbon Disulfide 75-15-0	V	5		CV											
Carbon Tetrachloride 56-23-5	V	5	1	CV	0.3	0.25	35,200								
Chlorinated Benzenes -	V	10		CV/CS											
Chlorobenzene 108-90-7	V	5	1	CV/CVS	100	100									
Chloroethane 75-00-3	V	10		CV											
Chloroform 67-66-3	V	5	1	E502.2	6	6	28,900	1,240							
Chloromethane 74-87-3	V	10	1	CV		5.7									
Dibromochloromethane -	V	5	1	CV	14	6									
Dichloroethenes -	V		1												
Ethyl Benzene 100-41-4	V	5	1	CV	680	3,100	32,000								
Ethylene Dibromide 106-43-4	V			d											
Ethylene Oxide 75-21-8	V														
Halomethanes -	V			E502.2	100										
Methylene Chloride 75-09-2	V	5	1	CV		4.7									
Pyrene 129-00-0	V	10	10	CS		0.0028									
Styrene 100-42-5	V	5		CV											
Tetrachloroethanes 79-34-5	V	5	1	E502.2											
Tetrachloroethene -	V	5	1	CV	5	0.8	5,280	840							
Toluene 108-88-3	V	5	1	CV	1,000	1,000	17,500								
Trichloroethanes 79-00-5	V	5	1	E502.2											
Trichloroethene 79-01-6	V	5	1	CV	5	2.7	45,000	21,900							
Vinyl Acetate 75-01-4	V	10		CV											
Xylenes (Total) 1330-20-7	V	5		CV											

**TABLE 3.3. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)  
STATEWIDE AND BASINWIDE (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS**

Parameter - CAS No.	Type (5)	Statewide Standards (a)										Basin Standards (b)		
		PQL MDL		Method (6)	Human Health Carcinogens/ Noncarcinogens (2) (5)		Aquatic Life (8)		Tables I,II,III (1)				Organics (7)	
									Aquatic Life		Agricul- tural Standard (3)	Domestic Water Supply (4)		
		Acute Value ug/l	Chronic Value ug/l		Acute Value (2) ug/l	Chronic Value (2) ug/l	Aquatic Life	Water Supply						
		RFP ug/l	CDH ug/l		Water Supply ug/l	Water and Fish ug/l	ug/l	ug/l	ug/l	ug/l	ug/l	ug/l		

**EXPLANATION OF TABLE**

CLP	= Contract Laboratory Program
CDH	= Colorado Department of Health
dis	= dissolved
EPA	= Environmental Protection Agency
pCi/l	= picocuries per liter
PCB	= polychlorinated biphenyl
PQL	= Practical Quantitation Level
SS	= species specific
TAL	= Target Analyte List
THM	= Total Trihalomethanes
TIC	= Tentatively Identified Compound
TVS	= Table Value Standard (hardness dependent), see Table III in (a)
MDL	= Minimum Detection Limit for radionuclides (pCi/l)
ug/l	= micrograms per liter
VOA	= Volatile Organic Analysis
CWQCC	= Colorado Water Quality Control Commission

(1) Table I = physical and biological parameters

Table II = inorganic parameters

Table III = metal parameters

Values in Tables I, II, and III for recreational uses, cold water biota and domestic water supply are not included.

(2) In the absence of specific, numeric standards for non-naturally occurring organics, the narrative standard is interpreted as zero with enforcement based on practical quantification levels (PQLs) as defined by CDH/WQCC or EPA

(3) All are 30-day standards except for nitrate+nitrite

(4) Ammonia, sulfide, chloride, sulfate, copper, iron, manganese, and zinc are 30-day standards, all others are 1-day standards

(5) type abbreviations are: A=anion; B=bacteria; C=cation; I=indicator; FP=field parameter; M=metal; P=pesticide; PP=pesticide/PCB; R=radionuclide; SV=semi-volatile; V=volatile

(6) method abbreviations are: CT=CLP-TAL; NC=non-CLP; CV=CLP-VOA; CS=CLP-SEMI; EP=EPA-PEST; CP=CLP-PEST; E=EPA; a = detected as total in CV;

b = detected as TICs in CS; c = detected as TIC in CV; d = not routinely monitored; e = monitored in discharge ponds; f = mixture-individual isomers detected.

(7) See Section 3.8.5 (2)(a) in (b)

(8) Where standard is below (more stringent than) PQL (CDH), PQL is standard.

(9) MDL for Radium 226 is 0.5; MDL for Radium 228 is 1.0

(10) See section 3.1.11 (f) (2) in (a)

(a) CDH/CWQCC, Colorado Water Quality Standards 3.1.0 (5 CCR 1002-8) 1/15/1974; amended 10/17/1991 (ARAR).

(Environmental Reporter 726:1001-1020:6/1990)

(b) CDH/CWQCC, Classifications and Numeric Standards for S. Platte River Basin, Laramie River Basin, Republican River Basin, Smoky Hill River Basin 3.8.0 (5 CCR 1002-8) 4/6/1981; amended 2/15/1990 - Basin-wide standards are ARAR.

**TABLE 3.4. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)  
STREAM SEGMENT (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS**

					Segment 4 & 5 Stream Classification and Water Quality Standards (b)(4)						
Parameter - CAS No.	Type (5)	PQL MDL		Method (6)	Tables A,B (1) ug/l	Table C Fish & Water Ingestion ug/l	Table D Radio- nuclide ug/l	Stream Segment Table (5)		Table 2 Radionuclides	
		RFP ug/l	CDH ug/l					Acute Value ug/l	Chronic Value ug/l	Woman Creek pCi/l	Walnut Creek pCi/l
Bicarbonate -	A	10,000		E310.1							
Carbonate -	A	10,000		E310.1							
Chloride	A	5,000		E325				250,000	250,000		
Chlorine 7782-50-5	A	1,000		E4500				3	3		
Fluoride	A	5,000		E340							
N as Nitrate	A	5,000		E353.1				10,000	10,000		
N as Nitrate+Nitrite	A	5,000		E353.1							
N as Nitrite	A	5,000		E354.1				1,000	1,000		
Sulfate	A	5,000		E375.4				250,000	250,000		
Sulfide	A										
Coliform (Fecal)	B	1		SM9221C							
Ammonia as N	C	5,000		E350				620	60		
Dioxin 1746-01-6	D			d,E613	0.00000022	0.000000013			0.000000013		
Sulfur	E	100,000		E600				2.0	2.0		
Dissolved Oxygen (mg/l)	FP	500		SM4500				5,000	5,000		
pH	FP	0.1		E150.1				6.5-9	6.5-9		
Specific Conductance (uS/cm)	FP	1		E120.1							
Temperature	FP										
Boron	I	5,000		E6010				750	750		
Total Dissolved Solids	I	10,000		E160.1							
Aluminum 7429-90-5	M	200		CT							
Antimony 7440-36-0	M	50		CT							
Arsenic 7740-38-2	M	10		CT				50			
Arsenic III -	M										
Arsenic V -	M										
Barium 7440-39-3	M	200		CT							
Beryllium 7440-41-7	M	5		CT							
Cadmium 7440-43-9	M	5		E213.2				TVS	TVS		
Calcium 7440-70-2	M	5,000		CT							
Cesium 7440-46-2	M	1,000		NC							
Chromium 7440-47-3	M	10		E218.2							
Chromium III -	M	5		SW8467196				50			
Chromium VI -	M	10		E218.5				TVS	TVS		
Cobalt 7440-48-4	M	50		CT							
Copper 7440-50-8	M	25		E220.2				TVS	TVS		
Cyanide -	M	10		E335.2				5	5		
Iron -	M	100		CT					300 (3)		
Lead 7439-92-1	M	5		E239.2				TVS	TVS		
Lithium 7439-93-2	M	100		NC							
Magnesium 7439-95-4	M	5000		CT							
Manganese 7439-96-5	M	15		CT					50 (3)		
Mercury 7439-97-6	M	0.2		CT					0.01		

**TABLE 3.4. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)  
STREAM SEGMENT (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS**

					Segment 4 & 5 Stream Classification and Water Quality Standards (b)(4)						
Parameter - CAS No.	Type (5)	PQL MDL		Method (6)	Tables A,B (1) ug/l	Table C Fish & Water Ingestion ug/l	Table D Radio- nuclide ug/l	Stream Segment Table (5)		Table 2 Radionuclides	
		RFP ug/l	CDH ug/l					Acute Value ug/l	Chronic Value ug/l	Woman Creek pCi/l	Walnut Creek pCi/l
Molybdenum 7439-93-7	M	200		NC							
Nickel 7440-02-0	M	40		CT				TVS	TVS		
Potassium 7440-09-7	M	5000		CT							
Selenium 7782-49-2	M	5		CT				10			
Silver 7440-22-4	M	10		E272.2				TVS	TVS		
Sodium 7440-23-5	M	5000		CT							
Strontium -	M	200		NC							
Thallium 7440-28-0	M	10		CT							
Tin 7440-31-5	M	200		NC							
Titanium 7440-32-6	M	10		E6010							
Tungsten 7440-33-7	M	10		E6010							
Vanadium 7440-62-2	M	50		CT							
Zinc 7440-66-6	M	20		CT				TVS	TVS		
2,4,5-TP Silvex	P		0.5	d	10						
2,4-Dichlorophenoxyacetic Acid (2,4-D) 94-75-7	P		1	d	100						
Acrolein 107-02-8	P		10								
Aldicarb 116-06-3	P		10		10						
Aldrin 309-00-2	P	0.05	0.1	E508	0.002 (6)	0.000074			0.000074		
Bromacil -	P										
Carbofuran 1563-66-2	P			d	36						
Chloranil -	P			E619							
Chlordane (Alpha) 57-74-9	P	0.5	1	E508	0.03 (6)	0.00046			0.00046		
Chlordane (Gamma) 57-74-9	P	0.5	1	E508	0.03 (6)	0.00046			0.00046		
Chlorpyrifos 2921-88-2	P		0.1								
DDT 50-29-3	P	0.1	0.1	E508	0.1 (6)	0.000024			0.000024		
DDT Metabolite (DDD) -	P	0.1	0.1	E508							
DDT Metabolite (DDE) -	P	0.1	0.1	E508							
Demeton 8065-48-3	P		1								
Diazinon 333-41-5	P										
Dieklrin 60-57-1	P	0.1	0.1	E508	0.002 (6)	0.000071			0.000071		
Endosulfan I 959-95-8	P	0.05	0.1	CP							
Endosulfan II 33213-65-9	P	0.1	0.1	CP							
Endosulfan Sulfate 1031-07-8	P	0.1	0.1	CP							
Endrin 72-20-8	P	0.1	0.1	CP	0.2						
Endrin Aldehyde 7421-93-4	P		0.1								
Endrin Ketone	P	0.1		CP							
Guthion 86-50-0	P		1.5								
Heptachlor 76-44-8	P	0.05	0.05	E508	0.008 (6)	0.00028			0.00028		
Heptachlor Epoxide 1024-57-3	P	0.05	0.05	CP	0.004 (6)						
Hexachlorocyclohexane, Alpha 608-73-1	P	0.05	0.05	E505		0.0092			0.0092		
Hexachlorocyclohexane, Beta 608-73-1	P	0.05	0.05	E505		0.0163			0.0163		
Hexachlorocyclohexane, BHC 608-73-1	P	0.05	0.05								
Hexachlorocyclohexane, Delta 608-73-1	P	0.05		CP							

**TABLE 3.4. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)**  
**STREAM SEGMENT (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS**

					Segment 4 & 5 Stream Classification and Water Quality Standards (b)(4)						
Parameter - CAS No.	Type (5)	PQL MDL		Method (6)	Tables A,B (1) ug/l	Table C Fish & Water Ingestion ug/l	Table D Radio- nuclide ug/l	Stream Segment Table (5)		Table 2 Radionuclides	
		RFP ug/l	CDH ug/l					Acute Value ug/l	Chronic Value ug/l	Woman Creek pCi/l	Walnut Creek pCi/l
Hexachlorocyclohexane, Tech. 608-73-1	P		0.2	E505		0.0123			0.0123		
Hexachlorocyclohexane, Lindane 58-89-9	P	0.05	0.05	E505	4	0.0186			0.0186		
Malathion 121-75-5	P		0.2								
Methoxychlor 72-43-5	P	0.5	0.5	CP	100						
Mirex 2385-85-5	P		0.1								
Parathion 56-38-2	P										
PCBs 1336-36-3	P	0.5	1	E508	0.005 (6)	0.000079			0.000079		
Simazine -	P			e,E608(1)/507(3)		4			4		
Toxaphene 8001-35-2	P	1	5	CP	5						
Vaponite 2 -	P										
Aroclor 1016 12674-11-2	PP	0.5		CP							
Aroclor 1221 11104-28-2	PP	0.5		CP							
Aroclor 1232 11141-16-5	PP	0.5		CP							
Aroclor 1242 53469-21-9	PP	0.5		CP							
Aroclor 1248 12672-29-6	PP	0.5		CP							
Aroclor 1254 11097-69-1	PP	1		CP							
Aroclor 1260 11096-82-5	PP	1		CP							
Atrazine 1912-24-9	PP			e,608(2)/507(3)		3			3		
Americium (pCi/l)	R									0.05	0.05
Americium 241 (pCi/l)	R	0.01					30				
Cesium 134 (pCi/l)	R	1			80		80			80	80
Cesium 137 (pCi/l)	R	1									
Gross Alpha (pCi/l)	R	2								7	11
Gross Beta (pCi/l)	R	4								5	19
Plutonium (pCi/l)	R									0.05	0.05
Plutonium 238+239+240 (pCi/l)	R	0.01					15				
Radium 226+228 (pCi/l)	R	0.5/1.0 (7)					5				
Strontium 89+90 (pCi/l)	R	1									
Strontium 90 (pCi/l)	R						8			8	8
Thorium 230+232 (pCi/l)	R						60				
Tritium (pCi/l)	R						20,000			500	500
Uranium 233+234 (pCi/l)	R										
Uranium 235 (pCi/l)	R	0.6									
Uranium 238 (pCi/l)	R	0.6									
Uranium (Total) (pCi/l)	R						40			5	10
1,2,4,5-Tetrachlorobenzene 95-94-3	SV		10	b	2 (6)						
1,2,4-Trichlorobenzene	SV	10		CS							
1,2-Dichlorobenzene (Ortho) 95-50-1	SV	10	1	CS	620						
1,2-Diphenylhydrazine 122-66-7	SV			b	0.05 (6)						
1,3-Dichlorobenzene (Meta) 541-73-1	SV	10	1	CS	620						
1,4-Dichlorobenzene (Para) 106-46-7	SV	10	1	CS	75						
2,4,5-Trichlorophenol 95-95-5	SV	50		CS	700						
2,4,6-Trichlorophenol 88-06-2	SV	10	50	E502.2	2.0 (6)	1.2		1.2			





**TABLE 3.4. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)**  
**STREAM SEGMENT (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS**

					Segment 4 & 5 Stream Classification and Water Quality Standards (b)(4)						
Parameter - CAS No.	Type (5)	PQL MDL		Method (6)	Tables A,B (1) ug/l	Table C Fish & Water Ingestion ug/l	Table D Radio- nuclide ug/l	Stream Segment Table (5)		Table 2 Radionuclides	
		RFP ug/l	CDH ug/l					Acute Value ug/l	Chronic Value ug/l	Woman Creek pCi/l	Walnut Creek pCi/l
Dichlorobenzidine 91-94-1	SV	20	10	E625		0.01			0.01		
Diethylphthalate -	SV	10	10	CS							
Dimethylphthalate -	SV	10	10	CS							
Di-n-butylphthalate -	SV	10	10	CS							
Di-n-octylphthalate -	SV	10		CS							
Ethylene Glycol 107-21-1	SV			d							
Fluoranthene 206-44-0	SV	10	10	CS							
Fluorene 86-73-7	SV	10	10	CS							
Formaldehyde 50-00-0	SV										
Haloethers -	SV										
Hexachlorobenzene 118-74-1	SV	10	10	E525	0.02 (6)	0.00072			0.00072		
Hexachlorobutadiene 87-68-3	SV	10	10	E525	14	0.45			0.45		
Hexachlorocyclopentadiene 77-47-4	SV	10	10	CS	49						
Hexachloroethane	SV	10	10	E525		1.9			1.9		
Hydrazine 302-01-2	SV										
Indeno(1,2,3-cd)pyrene	SV	10	10	CS							
Isophorone 78-59-1	SV	10	10	CS	1,050						
Naphthalene 91-20-3	SV	10	10	CS							
Nitrobenzene 98-95-3	SV	10	10	CS	3.5 (6)						
Nitrophenols -	SV										
Nitrosamines -	SV										
Nitrosodibutylamine 924-16-3	SV		10	b,E607		0.0064			0.0064		
Nitrosodiethylamine 55-18-5	SV		10	b,E607		0.0008			0.0008		
Nitrosodimethylamine 62-75-9	SV		10	b,E607		0.0014			0.0014		
Nitrosopyrrolidine 930-55-2	SV		10	b,E625		0.016			0.016		
N-Nitrosodiphenylamine 86-30-6	SV	10	10	b,E607		4.9			4.9		
N-Nitroso-di-n-propylamine -	SV	10	10	CSb							
Pentachlorinated Ethanes -	SV			b							
Pentachlorobenzene 608-93-5	SV		10	b	6 (6)						
Pentachlorophenol 87-86-5	SV	50	50	CS	200						
Phenanthrene 85-01-8	SV	10	10	CS							
Phenol 108-95-2	SV	10	50	CS							
Phthalate Esters -	SV			e							
Polynuclear Aromatic Hydrocarbons	SV		10	b,E610		0.0028			0.0028		
Vinyl Chloride 75-01-4	SV	10	2	CV	2						
1,1,1-Trichloroethane 71-55-6	V	5	1	CV	200						
1,1,2,2-Tetrachloroethane 79-34-5	V	5	1	CV		0.17			0.17		
1,1,2-Trichloroethane 79-00-5	V	5	1	E502.2	28	0.60			0.60		
1,1-Dichloroethane 75-34-3	V	5		CV							
1,1-Dichloroethene -	V	5	1	CV	7						
1,2-Dichloroethane 107-06-2	V	5	1	CV	5						
1,2-Dichloroethene (cis) -	V		1	a	70						
1,2-Dichloroethene (total) -	V	5		CV							
1,2-Dichloroethene (trans) -	V	5	1	a	70						

**TABLE 3.4. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)**  
**STREAM SEGMENT (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS**

				Segment 4 & 5 Stream Classification and Water Quality Standards (b)(4)							
Parameter - CAS No.	Type (5)	PQL MDL		Method (6)	Tables A,B (1) ug/l	Table C Fish & Water Ingestion ug/l	Table D Radio- nuclide ug/l	Stream Segment Table (5)		Table 2 Radionuclides	
		RFP ug/l	CDH ug/l					Acute Value ug/l	Chronic Value ug/l	Woman Creek pCi/l	Walnut Creek pCi/l
1,2-Dichloropropane 78-87-5	V	5	1	CV	0.56 (6)						
1,3-Dichloropropene (cis) 542-75-6	V	5	1	CV							
1,3-Dichloropropene (trans) 542-75-6	V	5	1	CV							
2-Butanone 78-93-3	V	10		CV							
2-Hexanone 591-78-6	V	10		CV							
4-Methyl-2-pentanone 108-10-1	V	10		CV							
Acetone 67-64-1	V	10		CV							
Acrylonitrile 107-13-1	V		5	E625		0.058			0.058		
Benzene 71-43-2	V	5	1	CV	5						
Bromodichloromethane 75-27-4	V	5	1	CV							
Bromoform 75-25-2	V	5	1	CV							
Bromomethane 74-83-9	V	10	1	CV							
Carbon Disulfide 75-15-0	V	5		CV							
Carbon Tetrachloride 56-23-5	V	1		CV	5						
Chlorinated Benzenes -	V	10		CV/CS							
Chlorobenzene 108-90-7	V	5	1	CV/CSV	300						
Chloroethane 75-00-3	V	10		CV							
Chloroform 67-66-3	V	5	1	E502.2	Tot THM <100*	0.19			0.19		
Chloromethane 74-87-3	V	10	1	CV							
Dibromochloromethane -	V	5	1	CV							
Dichloroethenes -	V		1								
Ethyl Benzene 100-41-4	V	5	1	CV	680						
Ethylene Dibromide 106-43-4	V			d							
Ethylene Oxide 75-21-8	V										
Halomethanes -	V			E502.2	100	0.19			0.19		
Methylene Chloride 75-09-2	V	5	1	CV							
Pyrene 129-00-0	V	10	10	CS							
Styrene 100-42-5	V	5		CV							
Tetrachloroethanes 79-34-5	V	5	1	E502.2		0.8			0.8		
Tetrachloroethene -	V	5	1	CV	10						
Toluene 108-88-3	V	5	1	CV	2,420						
Trichloroethanes 79-00-5	V	5	1	E502.2							
Trichloroethene 79-01-6	V	5	1	CV	5						
Vinyl Acetate 75-01-4	V	10		CV							
Xylenes (Total) 1330-20-7	V	5		CV							

**TABLE 3.4. POTENTIAL CHEMICAL-SPECIFIC BENCHMARKS (February 1, 1992)**  
**STREAM SEGMENT (CDH/CWQCC) SURFACE WATER QUALITY STANDARDS**

Segment 4 & 5 Stream Classification and Water Quality Standards (b)(4)											
Parameter - CAS No.	Type (5)	PQL MDL		Method (6)	Tables A,B (1) ug/l	Table C Fish & Water Ingestion ug/l	Table D Radio- nuclide ug/l	Stream Segment Table (5)		Table 2 Radionuclides	
		RFP	CDH					Acute Value	Chronic Value	Woman Creek	Walnut Creek
		ug/l	ug/l					ug/l	ug/l	pCi/l	pCi/l

**EXPLANATION OF TABLE**

*	= Total trihalomethanes:chloroform, bromoform, bromodichloromethane, dibromochloromethane
CLP	= Contract Laboratory Program
CDH	= Colorado Department of Health
dis	= dissolved
EPA	= Environmental Protection Agency
pCi/l	= picocuries per liter
PCB	= polychlorinated biphenyl
PQL	= Practical Quantitation Level
RFP	= Rocky Flats Plant
SS	= species specific
TAL	= Target Analyte List
THM	= Total Trihalomethanes
TIC	= Tentatively Identified Compound
TVS	= Table Value Standard (hardness dependent), see Table III in (a)
MDL	= Minimum Detection Limit for radionuclides (pCi/l)
ug/l	= micrograms per liter
VOA	= Volatile Organic Analysis
CWQCC	= Colorado Water Quality Control Commission

(1) In the absence of specific, numeric standards for non-naturally occurring organics, the narrative standard is interpreted as zero with enforcement based on practical quantification levels (PQLs) as defined by CDH/CWQCC or EPA

(2) Ammonia, sulfide, chloride, sulfate, copper, iron, manganese, and zinc are 30-day standards, all others are 1-day standards

(3) Lowest value given: dissolved or total recoverable

(4) Segment 5 standards are goals

(5) Includes Table 1: Additional Organic Chemical Standards (chronic only)

(6) Standard is below (more stringent than) PQL, therefore PQL is standard.

(7) MDL for Radium 226 is 0.5; MDL for Radium 228 is 1.0

(a) CDH/CWQCC, Colorado Water Quality Standards 3.1.0 (5 CCR 1002-8) 1/15/1974; amended 9/30/1989.  
 (Environmental Reporter 726:1001-1020:6/1990)

(b) CDH/CWQCC, Classifications and Numeric Standards for S. Platte River Basin, Laramie River Basin, Republican River Basin,  
 Smoky Hill River Basin 3.8.0 (5 CCR 1002-8) 4/6/1981; amended 2/15/1990.

ROCKY FLATS PLANT  
Phase I RFI/RI Work Plan  
Operable Unit 13  
100 Area

Manual 21100-WP-OU13.01  
Section No.: 4.0, REV. 0  
Page: 1 of 22  
Organization: Environmental Management

TITLE: RFI/RI Tasks

Approved By:

02/01/93  
Effective Date

  
Manager

10/9/92  
Date

#### 4.0 RCRA FACILITY INVESTIGATION/REMEDIAL INVESTIGATION TASKS

##### 4.1 PROJECT PLANNING

Project planning will consist of the activities necessary to initiate the Phase I RCRA Facility Investigation (RFI)/Remedial Investigation (RI) of the Individual Hazardous Substance Sites (IHSSs) in the 100 Area. Activities undertaken for this project have included a review of previous investigations, historical aerial photographs, and other historical information. Results of this review are presented in Section 2.0 of this work plan. Prior to field investigations, it is necessary to complete the review of the existing data, including plant records and plans, available aerial photographs, and new data which become available after preparation of this work plan. The IAG also requires the submittal of several existing reports to the regulatory agencies. These reports will be assembled and reviewed during the project planning task.

There are ongoing site studies at RFP of surface water and sediments, groundwater, geology, background geochemistry, and ambient air that may provide data that have bearing on the investigations in the 100 area. These data will be compiled and evaluated during the project planning activities. Data from investigations at overlapping OUs will also be reviewed. If available data from ongoing investigations meet the requirements of the Phase I sampling and analysis plan, the samples proposed in Section 6.0 need not be collected again.

Other project related documents are currently being prepared. The Sampling and Analysis Plan (SAP), which includes the site-wide Quality Assurance Project Plan (QAPjP) and Standard

Operating Procedures (SOP) for field activities, is currently being completed by EG&G. The Health and Safety Plan (HSP) is also being completed by EG&G. The Field Sampling Plan (FSP) is included as Section 6.0 of this document. The Phase I FSP will be revised as necessary based on the findings of the photo and records review.

## 4.2 COMMUNITY RELATIONS

In accordance with the IAG, dated January 22, 1991, the Communications Department at Rocky Flats has developed a plant-wide Community Relations Plan (CRP) to develop an interactive relationship with the public relating to environmental restoration activities. The Community Relations Plan, after review and comment by the public, has been accepted by the Environmental Protection Agency (EPA) and the Colorado Department of Health (CDH). This plan specifies activities planned to meet the legal requirements of CERCLA, RCRA and NEPA with respect to the Environmental Restoration (ER) Program at Rocky Flats. Accordingly, a site-specific CRP is not required for Operable Unit Number 13 (OU13). The ER program community relations activities include participation by plant representatives in informational workshops, meetings of the Rocky Flats Environmental Monitoring Council, briefings of the public on proposed remedial action plans, and meetings to solicit public comment on various ER program plans and actions.

The Communications Department is continuing other public information efforts to keep the public informed on ER activities and other issues related to plant operations. A Speakers Bureau program sends speakers to civic groups and educational organizations, while a public tour program allows the public to visit Rocky Flats. An Outreach Program is also in place in which plant officials visit elected officials, the news media, and business and civic organizations to further discuss issues related to Rocky Flats and ER activities. The Communications Department

receives numerous public inquiries which are answered through telephone conversations or by sending written informational materials to the requestor.

#### 4.3 FIELD INVESTIGATION

Phase I field investigations will be conducted at the IHSSs in the 100 Area to collect samples and data concerning the nature and extent of contamination, if any, at each site. The data and sample results will be used to support the Phase I Environmental Evaluation and Phase I Human Health Risk Assessment, as well as meet the objectives and data needs described in Section 5.0 of this work plan. Additional phase(s) of investigation and risk assessment may be required at IHSSs prior to Feasibility Studies.

Three types of activities will be performed during the Phase I field investigation: screening activities, sampling activities, and monitoring well installation. Screening activities include visual inspections, radiological surveys and soil gas surveys. Sampling activities include surface soil sampling, subsurface sampling using test borings, vadose water sampling, surface water sampling, and sediment sampling. Monitoring wells will be installed and sampled at specified locations and in some test borings.

Fourteen IHSSs have been included in OU13 in the 100 Area. These IHSSs have been grouped into two groups based on the contaminant source type and release mechanism of the sites. Because of the diverse nature of the IHSS groups, the Phase I field investigations for each group will be different. Specific field activities are described in the Phase I FSP in Section 6.0 of this work plan.

#### 4.4 SAMPLE ANALYSIS AND DATA VALIDATION

Samples collected during the Phase I field investigation will be analyzed for the parameters specified in the IAG as described in Section 6.4. Analytical procedures will be completed in accordance with the ER Program QAPjP. Project-specific quality assurance (QA) requirements are included in the Quality Assurance Addendum (QAA), Section 10.0 of this work plan. Section 6.0 of this work plan specifies Phase I analytical requirements, as well as sample containers, preservation and holding times, and field quality control (QC) requirements. Samples collected for this work plan will be analyzed by a Rocky Flats Plant (RFP) contract laboratory.

Phase I data will be reviewed and validated according to the data validation guidelines in the QAPjP and the Data Validation Functional Guidelines. These documents state that the results of data review and validation activities will be documented in data validation reports.

#### 4.5 DATA EVALUATION

Data collected during the Phase I 100 Area RI will be incorporated into the existing database with data from investigations at other OUs. The data will be used to better define site characteristics, source characteristics, the nature and extent of contamination, to support the baseline risk assessment and environmental evaluation, and to evaluate potential remedial alternatives.

##### 4.5.1 Site Characterization

Geologic and hydrogeologic data will be used to develop site maps and cross sections. Geologic data will be used to evaluate the stratigraphy of the alluvium and colluvium at each site and to determine the depth to bedrock and the bedrock type.



Hydrogeologic data will be used to characterize the unconfined aquifer at the sites. These data will include information about the following:

- Hydrostratigraphic characteristics of units present;
- Hydraulic gradients; and
- Water table depth and configuration.

To characterize the general groundwater flow regime within and adjacent to the IHSSs, groundwater flow modeling at an appropriate scale will be conducted. This flow modeling will initially consist of a single modeling project designed to include the IHSSs within OU13 and integrate consistently with site-wide groundwater flow modeling. The initial flow modeling will be used to construct flow paths from the IHSSs and to determine requirements for more detailed flow and transport modeling. Detailed flow and transport modeling will be done at the IHSS level as necessary.

To characterize the general surface water system of OU13, a regional scale surface water flow and transport model will be developed. Where required, IHSS specific flow and transport models will be developed and integrated to the regional scale model.

Data collected during surface water and sediment sampling, including background sampling, will be used to characterize the 100 Area.

#### 4.5.2 Source Characterization

The data collected during the Phase I RI will be evaluated to identify potential sources of contamination at the IHSSs. Potential sources include wastes disposed at the sites and off-site sources located topographically and/or hydraulically upgradient of the sites. Analytical data from

soil and sediment sampling at the sites will be used to characterize the nature, lateral and vertical extent, and volume of source materials, if present.

#### 4.5.3 Nature and Extent of Contamination

Graphical and, where appropriate, statistical methods will be used to identify chemical and radioactive contaminants present in the soil, sediment, surface water, and groundwater and to estimate the concentrations and distributions of the contaminants. Results of sampling will be compared with results of the ongoing background geochemical characterization to assess the chemical concentrations above background levels. Products of this analysis may include isopleth maps, cross sections and profiles, chemical tables, and statistical results.

#### 4.6 PHASE I BASELINE RISK ASSESSMENT

Using existing data and data collected during the tasks described above, a Phase I baseline risk assessment will be prepared for OU13 to evaluate the potential risks to public health and the environment in the absence of remedial action. The Phase I baseline risk assessment will provide the basis for determining whether additional investigations are necessary at the IHSSs and whether remedial actions are necessary.

The risk assessment will be accomplished in five general steps:

- Identification of chemicals of concern;
- Exposure assessment;
- Toxicity assessment;
- Risk characterization; and
- Presentation of uncertainties and limitations of the analysis.

The Phase I risk assessment will address the potential public health and environmental impacts associated with the site under the no-action alternative (no remedial action taken) based on the data available. This assessment will aid in the preliminary screening site remedies based on the contaminants of concern and the environmental media associated with potential risks to public health and the environment.

The objectives and description of work for each risk assessment step are described in detail in the Human Health Risk Assessment Plan for OU13, Section 8.0 of this work plan. The Environmental Evaluation Work Plan for OU13 is Section 9.0 of this work plan.

#### 4.7 DEVELOPMENT AND SCREENING OF ALTERNATIVES

Remedial action alternatives reflect remedial action objectives aimed at protecting human health and the environment and should specify contaminants, exposure routes and receptors, and a preliminary remediation goal (e.g., an acceptable contaminant range).

##### 4.7.1 Surficial Materials, Bedrock, Surface Water and Sediments, and Groundwater

###### 4.7.1.1 Development and Screening of Remedial Alternatives

This section identifies potential technologies applicable to remediation of contaminated soils, bedrock, surface water, surficial materials, and groundwater at OU13. The identified technologies are based on the preliminary site characterization developed in Section 2.0. Identification and screening of technologies and assembling an initial screening of alternatives will be conducted simultaneously with the RFI/RI. However, investigation of this OU is in its early stages; thus, remedial alternatives are only briefly reviewed in this section. A more detailed evaluation of the remedial alternatives for OU13 will be addressed in the feasibility study (FS).

As stated in the IAG, general compliance with both RCRA and CERCLA is required for this OU. However, the outline presented in the CERCLA Guidelines provides the greatest detail and ensures compliance with RCRA. Consequently, the processes employed to develop and evaluate alternatives for OU13 are outlined in Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA (EPA, 1988).

The following steps were used to develop preliminary remedial alternatives for the OU13 area:

- Develop remedial action objectives of a general nature appropriate for site-specific, risk-related factors and based on chemical-specific and radionuclide-specific standards when available.
- Develop a list of actions appropriate for the bedrock, surface water, surficial materials, and groundwater at OU13 (such as containment, treatment, and/or removal) that may be implemented to satisfy the objectives defined in the previous step. These actions are generally referred to as "general response actions" in EPA guidelines.
- Identify and screen technology groups for each general response action. General response actions can each be further defined to include groups of technologies by which an action can be accomplished. Screening will eliminate those groups that are not technically feasible at the site.
- Identify and evaluate process options for each technology group to select a process option representing each technology group under consideration. Although specific process options are selected for alternative development and evaluation, these processes are intended to represent the broader range of options within a general technology group.
- Assemble the selected representative technologies into site closure and corrective action alternatives for the bedrock, surface water, surficial materials and groundwater of the IHSS areas of OU13 that represent a range of treatment and containment combinations, as appropriate.

- Screen the assembled alternatives against the short- and long-term aspects of three broad criteria: effectiveness, implementability, and cost. Because the screening evaluation reduces the number of alternatives that will undergo thorough and extensive analyses, alternatives will be evaluated in less detail than subsequent evaluations.

Determining the effectiveness of alternatives involves an evaluation of the protection of human health and the environment achieved by a remedial action during construction and implementation and after the response objectives have been met. Evaluation of short-term effectiveness is based on protection of the community and workers, impacts to the environment, and the time required to meet remedial response objectives. Long-term effectiveness addresses the risk remaining to human health and the environment. It is based on the percentage of permanent destruction, decreased mobility, and/or reduction in volume of toxic compounds achieved after response objectives have been met.

Implementability is a measure of both the technical and administrative feasibility of constructing, operating, and maintaining a remedial action alternative. It is used during screening to evaluate the combinations of process options with respect to the site-specific conditions. Technical feasibility refers to the ability to construct, reliably operate, and comply with action-specific (technology-specific) requirements in order to complete the remedial action. Administrative feasibility refers to the ability to obtain required permits and approvals; to obtain the necessary services and capacity for treatment, storage, and disposal of hazardous wastes; and to obtain essential equipment and technical expertise.

Cost estimates for screening will be derived from cost curves, generic unit costs, vendor information, conventional cost estimating guides, and prior estimates made for similar sites at RFP, with modifications made for current RFP conditions. Precise estimates are not necessary. However, the cost estimates for comparison and screening will have the same relative accuracy.

The cost estimating procedures used during screening are similar to those that will be used during the later detailed alternatives analyses. However, the later detailed analysis will receive more in-depth and detailed estimates for the components of each alternative. The screening cost estimates will include capital, operating, and maintenance costs. The operating and maintenance costs will be calculated for the lifetime of the treatment operations at the site. Present worth cost analysis will be used to make the costs for the various alternatives for the various alternatives comparable.

Alternatives with the most favorable results from the composite evaluation will be retained for further scrutiny during the detailed analysis. Not more than ten alternatives will be retained for detailed analysis (including containment and no action). At that time, it may be determined that additional site-specific information or technology-specific treatability studies are necessary for an objective detailed analysis. It will also be necessary to identify and verify the action-specific applicable or relevant and appropriate requirements (ARARs) for each alternative.

The Phase I RFI/RI Work Plan identifies the appropriate level of alternatives analyses and involves listing general response actions most applicable to the type of site under investigation. General response actions are broadly defined as those that may satisfy the objectives for remediation defined for OU13. Those objectives include the protection of human health and the environment from ingestion, dermal contact, or inhalation of contaminants that may be present in the bedrock, wastes, surficial materials, surface water, or groundwater in the OU13 area through remediation. Table 4.1 provides a list and description of general response actions and typical technologies associated with remediating soils, wastes, groundwater, surficial materials, and surface water. Table 4.1 also includes a general statement regarding the applicability of the general response action to potential exposure pathways. Not all of the alternative response actions and typical technologies listed may be appropriate for the IHSS areas of OU13. Some will be discarded during the screening of alternatives.

**TABLE 4.1**

**General Response Actions  
Typical Associated Remedial Technologies and Evaluation**

General Response Action	Description	Typical General Response Technologies	Action to Potential Pathways
No Action.	No remedial action taken at site.	Some monitoring and analyses may be performed.	National Contingency Plan requires consideration of no action as an alternative. Would not address potential pathways, although existing access restriction would continue to control onsite contact.
Access and Use Restrictions.	Permanent prevention of entry into contaminated area of site. Control of land use.	Site security, fencing, deed use restrictions, and warning signs.	Could control onsite exposure and reduce potential for offsite exposure. Site security fence and some signs are in place. Additional short-term or long-term access restrictions would likely be part of most remedial actions.
Containment	In-place actions taken to prevent migration of contaminants.	Capping, groundwater containment barriers, soil stabilization, and enhanced vegetation.	If applied to source, could be used to control all pathways. If applied to transport media, could be used to mitigate past releases (except air).
Pumping	Transfer of accumulated subsurface or surface contaminated water, usually to treatment and disposal.	Groundwater pumping, leachate collection, and liquid removal from surface impoundments.	Applicable to leachate removal prior to in situ treatment or waste removal. Applicable removal of contaminated groundwater and bulk liquids (for example, from buried drums).
Removal	Excavation and transport of primarily nonaqueous contaminated material from area of concern to treatment or disposal area.	Excavation and transfer of drums, soils, sediments, wastes, and contaminated structures.	If applied to source, could be used to control all pathways. If applied to transport media, will control corresponding pathway. Must be used with treatment or disposal response actions to be effective.

**TABLE 4.1 (Continued)**

**General Response Actions**

**Typical Associated Technologies and Evaluation**

<b>General Response Action</b>	<b>Description</b>	<b>Typical General Response Technologies</b>	<b>Action to Potential Pathways</b>
<b>In Situ Treatment</b>	Application of technologies in situ to change the in-place physical or chemical characteristics of contaminated material.	In situ vitrification and bioremediation.	Applied to source, could be used to control all pathways. Applied to transport media, could be used to control corresponding pathways.
<b>Storage</b>	Temporary stockpiling of removed material in a storage area or facility prior to treatment or disposal.	Temporary storage structures.	May be useful as a means to implement removal actions, but definition would not be considered a final action for pathways.
<b>Disposal</b>	Final placement of removed contaminated material or treatment residue in a permanent storage facility.	Permitted landfills and repositories.	With source removal, could be used to control all pathways. With removal of contaminated transport media, could be used to control corresponding pathway (except air).
<b>Monitoring</b>	Short-and/or long-term monitoring is implemented to assess site conditions and contamination levels.	Sediment, soil, surface water, and groundwater sampling and analysis.	RCRA requires post-closure monitoring to assess performance of closure and corrective action implementation.



The response actions outlined in Table 4.1 must be applied to the potential exposure pathways that will be identified for OU13. The response actions may provide control over all or some of the potential pathways. Partially effective response actions can be combined to form complementary sets of response actions that control all pathways.

In general terms, potential human exposure may be avoided by prevention of contaminant release, transport, and/or contact. Thus, application of the response actions may be considered at three different points in each potential exposure pathway: (1) at the point where the contaminant could be released from the source, (2) in the transport medium, and (3) at the point where contact with the released contaminant could be prevented.

While the identification of general response actions is discussed above, the selection of the most appropriate action or combination of actions is not warranted at this time. Site and contaminant data are not sufficient to initiate the screening process. Phase I will generate data necessary to characterize the source and soils and will evaluate the impact of OU13 on surface water, groundwater, air, the environment, and biota in addition to characterizing potential contaminant migration pathways. Data obtained from these investigations will:

- Describe the physical characteristics of the site;
- Define sources of contamination;
- Determine the nature and extent of contamination in soil, groundwater, surface water, sediments, and air;
- Describe contaminant fate and transport; and
- Describe receptors.

These data will provide information for the preliminary screening of alternatives and a thorough, comparative evaluation of the technologies with respect to implementability, effectiveness, and cost. This information will allow for informed decisions to be made with respect to the selection of preferred technologies. The Field Sampling and Analysis Plan (FSAP) in Section 6.0 describes the methodology that will be followed to obtain the required information for the Phase I RFI/RI characterization.

### Detailed Analysis of Remedial Alternatives

The detailed analysis of each alternative will be performed when sufficient data are generated. The detailed analysis and selection of alternatives is not a final decision-making process; rather, it is the process of analyzing and comparing relevant information in order to select a preferred remedial action. In accordance with the NCP, containment technologies will generally be appropriate remedies for wastes that pose a relatively low-level threat or where treatment is impracticable (EPA, 1991). Each appropriate alternative will be assessed in terms of nine evaluation criteria, and the assessments will be compared to identify the key attributes among the alternatives. Assessment based on the nine evaluation criteria is necessary for the Corrective Measure Study (CMS) and the subsequent Corrective Action Decision (CAD)/Record of Decision (ROD). The nine evaluation criteria are as follows:

1. Overall protection of human health and the environment;
2. ARARs;
3. Long-term effectiveness and permanence;
4. Reduction of toxicity, mobility, or volume;
5. Short-term effectiveness;
6. Implementability;

7. Cost;
8. State acceptance; and
9. Community acceptance.

These criteria are described in recently revised guidelines provided in the National Contingency Plan (NCP). The first two criteria are considered standards because they must be evaluated before further consideration of the remaining criteria. The next five criteria are considered the balancing items on which the analysis is based. The final two criteria are addressed during the final decision-making process after completion of the CMS/FS.

#### 4.7.2 Air

Atmospheric transport is characterized by short migration times, relatively large areas of exposure, and an inability to mitigate the potential consequences of a contaminant release once it occurs. As such, effective air pathway contaminant control will emphasize source emissions reduction and containment prior to atmospheric release. Conventional technologies that may be employed during OU13 Work Plan implementation to suppress fugitive dust and volatile organic emissions include application of water sprays, surfactants, or dust suppressants and installation of wind-screens or membrane coverings. Such methods will be applied when personnel protection monitoring (as implemented according to the Site-Specific Health and Safety Plan) indicates the need for mitigative action during Work Plan implementation.

### 4.8 TREATABILITY STUDIES

This task includes efforts to provide technical support in the form of bench-scale treatability tests to the Rocky Flats Plant ER Program in the event that treatability studies are necessary or

appropriate to support the OU13 RFI/RI. EG&G has prepared a site-wide Treatability Studies Plan which addresses this Task. The site-wide studies will be utilized as appropriate for OU13.

Treatability studies are conducted primarily to: (1) provide sufficient data to allow treatment alternatives to be fully developed and evaluated during the detailed analysis and to support the design of a selected remedial alternative; and (2) reduce cost and performance uncertainties for treatment alternatives to acceptable levels so that a remedy can be selected. Treatability study requirements are developed during the development and screening of remedial alternatives and include all available data from the current study as well as prior studies.

Numerous technologies that appear to be potentially applicable for treating OU13 will be screened for treatability testing. The technologies selected for screening will be limited to those already commercially established or those which have demonstrated potential for processing spent solvents, radionuclides, oils, and similar contaminants. Innovative and alternative technologies not meeting the above requirements will not be considered.

Depending on the hydraulic properties of the unconfined aquifer considered for remediation, it may be feasible to collect groundwater for treatment above ground. In that case, the following technologies have been identified for potential testing:

Chemical Oxidation of Organics - Chemical oxidation is used to degrade hazardous organic materials to less toxic compounds. Oxidation systems, particularly those using ultraviolet (UV) light, ozone, and hydrogen peroxide, are powerful tools for treating a wide variety of common organic environmental contaminants. Disadvantages are similar to those for inorganic oxidation reduction: potential nontarget organics and inorganics can produce undesirable side products and increase oxidant requirements.

Granular Activated Carbon (GAC) Adsorption of Organics - GAC adsorption is the most fully developed and widely used technology for treating groundwater contaminated with organics. It is effective for the removal of a wide range of organics from aqueous waste streams. Bench-scale testing consists of running a series of descriptive tests to determine isotherms for the groundwater contaminants. GAC is typically regenerated with a thermal process, and the regeneration process can be performed at either off-site or on-site facilities.

Reverse Osmosis - Reverse osmosis processes involve the use of semipermeable membranes. By applying water pressure greater than the osmotic pressure to one side of the membrane, water is passed through the membrane while particulate, salts, and high molecular weight organics are retained. However, the retained, highly concentrated solution (retentate) contains dissolved salts as well as the target contaminants, and requires further treatment or disposal.

Air Stripping - Air stripping Is a proven technology for removal of volatile and semivolatile contaminants from water. This process involves the transfer of contaminants from a contaminated liquid phase to a vapor phase by passing the two countercurrent streams through a packed tower. Air emission treatment is generally required, with vapor phase activated-carbon systems being the most commonly used process for this purpose, though other alternatives, such as oxidation and incineration, exist. The vapor phase treatment unit is generally costly.

Distillation - Distillation is a process that involves separating compounds by means of their boiling point characteristics. The primary use of distillation is for reclaiming spent solvents from industrial processes, and it is generally applicable only to rather concentrated solutions. The process can be used to separate various volatile compounds

or to separate mixtures of organics into light and heavy fractions. The light fraction can usually be recycled or used as a boiler feed, while the heavy fraction requires further treatment.

**Biological Reactors** - Biological reactors utilize microorganisms to remove organic contaminants from the water. Most organic contaminants can be biologically degraded by introducing the appropriate microorganisms. High concentrations of some organics and the presence of metals may prove toxic to the organisms, however, and pretreatment may be required. Several types of aerobic reactors exist, including activated sludge systems, trickling filters, rotating biological contactors, and immobilized cell reactors. In general, these methods generate large amounts of sludge, requiring disposal.

**Sorption of Radionuclides** - Sorption of inorganics, metals, and radionuclides is a standard technique for removal and concentration of these contaminants from wastewater. Common and proven sorption processes include ion exchange and GAC, while less-proven techniques involve the use of activated alumina, bone char, and proprietary sorption media. The sorption media are generally chemically regenerated, which results in a concentrated side stream requiring further treatment or disposal. Ion exchange and GAC sorbents are addressed separately elsewhere in this subsection, while the use of activated alumina and bone char are discussed below.

Activated alumina is a porous form of aluminum oxide with a large surface area. For removal of aqueous contaminants, activated alumina is typically used in a column similar to that for ion exchange. It has been proven successful in the removal of arsenic and fluoride from groundwater. More recently, activated alumina has shown promise in absorbing plutonium from a low-level wastewater effluent at the Hanford Site. In the same study, plutonium adsorption on bone char was the most rapid and gave the highest

decontamination factors. Waste-stream specific laboratory testing would provide valuable information on the suitability of these sorbents for low-level radionuclide removal.

**Ion Exchange of Radionuclides** - Ion exchange processes are used for a wide range of water treatment application, including commonly recognized systems such as demineralizers and water softeners. The goal of an ion exchange system is to remove undesirable ions of a certain type(s) from a solution and replace them with more acceptable ions. Radionuclides are commonly removed from waste streams at nuclear facilities using ion exchange.

Ion exchange resins, particularly anion exchange resins, have been used to recover uranium from mine run-off water for many years. Extensive studies on the laboratory scale report removal of uranium from natural waters as high as 99 percent. A small full-scale ion exchange system was capable of removing uranium from drinking water supplies to as low as ug/L. Ion exchange resins are typically rechargeable; however, the resins used in radioactive applications are generally only used once and are then disposed of as solid waste.

In cases where collection of groundwater is not feasible or practical, the following technologies have been identified for potential testing:

**In Situ Biological Treatment** - Depending on the effective porosity of the soils, in situ biological treatment may be feasible. In situ biological treatment of groundwater involves the stimulation of biological growth in the contaminated zone in order to reduce the contaminant concentrations. Microorganisms that can use some or all of the contaminants as substrates will normally exist in a contaminated environment. The microorganisms are stimulated to increase their biological growth and consumption of contaminants through

addition of essential nutrients. Aerobic treatment systems also require the introduction of oxygen. In situ treatment is dependent on geological and hydrological conditions. The process is relatively inexpensive.

Vacuum Extraction - Volatile contaminants can be removed from soil using vacuum extraction, which is an in situ treatment technology that involves the air stripping of contaminants by inducing a vapor flow through the soil. Since this technology involves the transfer of contaminants to the vapor, air emission treatment is generally required. The efficiency of the process is highly dependent on geologic conditions, and would tend to be ineffective in low-permeability materials.

In cases where contaminants are entrained in soils, the soil (such as surface soil) is accessible, and the contamination is of limited areal extent, the following technologies have been identified for potential testing:

Solidification/Stabilization - Solidification is a process in which contaminants are mechanically bound to solidification agents, reducing their mobility. This produces a solid matrix of waste with high structural integrity. Stabilization usually involves the addition of a chemical reagent to react with the contaminant, producing a less mobile or less toxic compound. Solidification and stabilization are frequently used together and are a well-established method for reducing the mobility and toxicity of hazardous wastes. This process generates large volumes of solidified materials requiring disposal.

Vitrification - The vitrification process involves heating the waste matrix to a very high temperature and either combining the matrix with molten glass or heating the matrix until it melts. Once cooled, the molten mass solidifies into a stable, noncrystalline solid resistant to leaching of inorganic, metal, and radionuclide contaminants. Organic



components are destroyed by pyrolysis. The process can be conducted either in situ or off site; however, the process is generally expensive.

**Physical Separation** - Soil contaminants are often found to be associated with a particular size fraction of soils, most often fine particles. In these cases, fractionation of the soil based on particle size can be an effective means of reducing the volume of the material that requires further treatment. The processes used for soil size fractionation include screening, classification, flotation, and gravity concentration.

**Soil Washing** - Soil washing is based on the principle of contaminant removal from soil by washing with two liquid solutions. Washing agents include water, acids, solvents, surfactants, and chelators. With the selection of appropriate washing solutions, soil washing technology can potentially be used to remove organics, inorganics, metals, and radionuclides. The wash solution containing the contaminants will require treatment and/or disposal.

#### 4.9 REMEDIAL INVESTIGATION REPORT

An RI report will be prepared summarizing the data obtained during the Phase I field work and data collected from previous and ongoing investigations. This report will:

- Describe in detail the field activities that serve as a basis for the RI report. This will include any deviations from the work plan that occurred during implementation of the field investigation.

- Discuss site physical conditions. This discussion will include surface features, meteorology, surface water hydrology, surficial and subsurface geology, groundwater hydrology, demography and land use, and ecology.
- Present a Preliminary Site Characterization based on all RFI/RI activities at OU13 and characterize the nature and extent of contamination. The media to be addressed will include contaminant sources, soils, sediments, groundwater, surface water, air, and biota.
- Discuss contaminant fate and transport. This discussion will include potential migration routes, contaminant persistence, chemical attenuation processes and potential receptors.
- Present a baseline risk assessment. The risk assessment will include human health and environmental evaluations.
- Present a summary of the findings and conclusions.

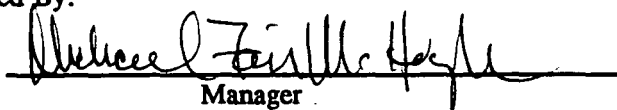
ROCKY FLATS PLANT  
Phase I RFI/RI Work Plan  
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## 5.0 DATA QUALITY OBJECTIVES AND DATA NEEDS

### 5.1 DATA QUALITY OBJECTIVES

Data Quality Objectives (DQOs) are established to define data needs for each of the RFI/RI tasks, coordinate collection activities to support those needs, and to ensure the quality and quantity of resultant data. Collectively the data are used to make decisions regarding the risks the site poses to human health and the environment and to make decisions regarding which remedial measures are appropriate to mitigate the risks. DQOs are developed interactively with ongoing RFI/RI activities. The DQO development process is flexible, iterative, and dependant upon evaluation of existing data, and data that become available as a result of RFI/RI activities. Three stages are used in the development of DQOs, and each of the stages is outlined below (EPA, 1987).

#### Stage 1 - Identify Decision Types

- Identify and involve data users;
- Evaluate available data;
- Develop a conceptual model of the study site; and
- Specify RFI/RI objectives, and anticipate the decisions necessary to achieve the objectives.

### **Stage 2 - Identify Data Uses and Needs**

- Identify data uses;
- Identify data types;
- Identify data quality needs;
- Identify data quantity needs;
- Evaluate sampling and analysis options; and
- Review data precision, accuracy, representativeness, completeness, and comparability (PARCC).

### **Stage 3 - Design Data Collection Program**

- Assemble data collection components; and
- Develop data collection documentation.

The DQO elements are continually revised and reevaluated on the basis of new data developed during each phase of the RFI/RI. As the environmental characteristics and the nature of contamination of the study area become better understood, additional data requirements will become apparent and both the DQOs and the Field Sampling and Analysis Plan (FSAP) may evolve in response to these requirements. The following discussion addresses each of the DQO elements.

### 5.1.1 Stage 1 Identification of Decision Types

#### 5.1.1.1 Identification of Data Users

The following is a list of agencies and organizations that are the principal decision makers and end-users of data that will be generated during the OU13 Phase I RFI/RI (ERP, 1991).

United States Environmental Protection Agency, Region VIII, Waste Management Division Director, Federal Facilities Branch Chief, and the Rocky Flats Remedial Project Manager.

State of Colorado Department of Health, Hazardous Materials and Waste Management Division Director, Hazardous Waste Section Leader, Hazardous Waste Facilities Unit Leader, and the Monitoring and Enforcement Unit Leader.

United States Department of Energy, Office of Environmental Restoration and Waste Management, Secretary of Energy, and the Acting Assistant Secretary for Environmental Restoration and Waste Management.

United States Department of Energy, Rocky Flats Office Manager, Assistant Manager for Environmental Management, and the Acting Environmental Restoration Division Director.

EG&G Rocky Flats Plant, Environmental Management Department, Associate General Manager for Environmental Restoration and Waste Management, Environmental Management Department Director, Environmental Management Department Division Managers, and matrix project personnel from other Rocky Flats Plant or external EG&G organizations.

EG&G Rocky Flats Plant technical specialists and subcontractors responsible for supervising, coordinating and performing Environmental Restoration activities (ERP, 1991i).

#### 5.1.1.2 Evaluation of Available Data

Existing data are described in Section 2 of this document. Soils and geologic data collection activities in the vicinity of OU13 have been primarily directed toward defining the RFP environmental setting. Much of the data were developed as a result of the RFP Geological Characterization including chemical data used to characterize the types and sources of contamination present in the soils and groundwater. Chemical data continue to be collected from monitoring well 4486 as part of the overall RFP characterization monitoring program. The available soils and geology data were not developed for the specific purpose of characterizing OU13.

Existing ambient air monitoring programs characterize the RFP site on an area-wide basis for plutonium and americium. This data is not specific to any of the OU13 IHSS sources, but provides a baseline for the RFP and is collected according to air sampling procedures specified in EMD Operating Procedures Manual No. 5-21000-OPS-AP, Volume VI, Air.

Surface water data (VOCs, metals, water quality, and radiochemistry) for OU13 are available from seven sampling stations (SED118, SW018, SW019, SW020, SW022, SW023, and SW093). Four of the stations (SW019, SW020, SW022, and SW023) are located within OU13; however, only SW019 is in a location that receives runoff from OU13. The seven other surface water sampling stations receive runoff from other OUs.

Data for air quality, surface water, groundwater, soils, and geology are being validated in accordance with sections 3.4 and 3.7 of the QAPjP for data validation guidelines and data usability criteria respectively. Some of the data are validated and accepted, some are validated with qualifications, some have been rejected, and some have yet to go through the validation process. Appendices D, E, and F list the available analytical data and identify which samples

have been validated. A summary evaluation of the data available for each IHSS located in OU13 is given below.

North Chemical Storage Site (IHSS 117.1). This site was used to store non-radioactive construction debris, waste metal, and scrap metal. Existing data for this site are available from piezometers and groundwater monitor wells P114789, P214689, P115589, and P218089. The available data characterize the site's soils and geology.

Middle Chemical Storage Site (IHSS 117.2). This site was used as a non-radioactive chemical storage facility. Existing soils and geologic data for this are limited to piezometers located in the vicinity of the site. These piezometers are P115589, P213689, and P214089.

South Chemical Storage Site (IHSS 117.3). This site was used as a storage area for pallets, cargo containers and new drums, and in one instance it is believed the site was used for the storage of a contaminated glovebox. Existing data for this site characterize soils geology and groundwater in the vicinity. These data are available from piezometers and monitor wells P313489, P418289, 6186. A radiometric survey for gross contamination was conducted for this area.

Oil Burn Pit Number 1 Waste Leak (IHSS 128). Approximately 200 gallons of radioactively contaminated waste oil were burned in an open pit in 1956. Data for soils and geology are available from piezometer P114889. Air monitoring data collected at the time the oil was burned may also be available.

Lithium Metal Destruction Site (IHSS 134). This area contains the reaction products from oxidation of magnesium and lithium metal coated with machine oils that may have contained perchloroethylene. Existing data for soils and geology are available from piezometers P114889 and P115489.

Waste Spills (IHSS 148). The soils of this site have reportedly been contaminated by spills of nitrates and possibly of unknown radioactive compounds. Existing data for this site is limited to a radiometric survey for gross contamination and surface water sampling station SW019.

Fuel Oil Tank (IHSS 152). This facility consists of an 800,000-gallon storage tank that is presently in operation, surrounded by an earthen dike, and containing No. 6 fuel oil. Approximately 700 gallons of fuel oil was spilled, cleaned up, and recycled in 1971. A similar spill of 400 gallons occurred in 1979. Existing data for this site is limited to a radiometric survey that indicated low levels of radioactivity were present.

North Area Radioactive Site (IHSS 157.1). This site is contaminated with unknown volumes of depleted uranium and beryllium. Existing data for this site include groundwater data from monitor well 4486, soil samples taken in the year 1953, and a radiometric survey for gross contamination.

Building 551 Radioactive Site (IHSS 158). This site was used as loading area and as a temporary holding area for items contaminated with low levels of uranium. Existing data for this site include soils and geology data from piezometers P115589 and P214689.

Waste Peroxide Drum Burial (IHSS 169). This site is the reported location of a buried single 55-gallon drum of hydrogen peroxide. This incident is probably the same incident described as IHSS 191. The evaluation of available data for IHSS 191 is given below.

Solvent Burning Ground (IHSS 171). This site was used for training fire-fighting personnel and may be contaminated with waste oil and gasoline. Existing data characterizing this site's soils and geology are available from piezometer P114889.



Valve Vault (IHSS 186). This was the site of a process waste line leak. Unknown volumes of liquid waste carrying radioactive constituents and other unknown chemicals leaked into the soil at this location. Existing data for soils and geology are available from piezometer P114789.

Caustic Leak (IHSS 190). This was the site of two leaks of sodium hydroxide from an above-ground storage tank. One of the leaks resulted in a release to the environment, and the other did not. There are no known sources of soils, geology, or groundwater data for this site. Surface water data is available from sampling station SW019.

Hydrogen Peroxide Spill (IHSS 191). This was the site of a release of hydrogen peroxide from a 55-gallon drum. There do not appear to be any sources of data for this site.

#### 5.1.1.3 Site Conceptual Model

Conceptual models of IHSSs in OU13 have been developed and are presented in Section 2.3 of this document. The models include a description of potential sources of contamination, release mechanisms, transport media, exposure routes, and potential receptors. The conceptual models were developed by organizing the IHSSs into two logical groups based upon the secondary source type, potential exposure routes and transport mechanisms. The two groups and the IHSSs that compose each group are listed below. IHSSs 128 and 148 are listed in both groups because they each exhibit characteristics of both groups.

- Releases originating above ground and affecting surficial materials:  
117.1, 117.2, 117.3, 128, 134, 148, 152, 157.1, 158, 171, 190, and 191.
- Releases originating and affecting transport media below the ground surface:  
122, 128, 148, and 186.

The conceptual models will be an aid in identifying exposure pathways and to evaluate the potential risks to human health and the environment posed by the contamination present in OU13.

#### 5.1.1.4 Data Objectives and Decisions

The DQO process requires that specific data objectives be defined; formulation of the objectives leads to the identification of data needs. The data objectives for the OU13 RFI/RI Work Plan are summarized in Table 5.1. Data needs are expected to evolve based upon new information generated as the Work Plan is implemented. From the information generated by the RFI/RI, decisions can be made regarding whether remediation is necessary and which remedial alternatives would be appropriate.

### 5.1.2 Stage 2 - Identify Data Uses and Needs

#### 5.1.2.1 Identify Data Uses

The principal uses of RFI/RI data have been defined in Data Quality Objectives for Remedial Response Activities and are listed below (EPA, 1987).

- **Site Characterization** - data are used to determine the nature and extent of contamination at a site;
- **Health and Safety** - data are used to establish the level of protection needed for onsite workers and to determine if there is imminent danger to the surrounding population;
- **Risk Assessment** - data are used to evaluate the threat posed by the site to public health and the environment;
- **Evaluation of Alternatives** - data are used to evaluate which remedial technologies may be appropriate;

Table 5.1 Phase I RFI/RI Analytical Data Quality Objectives

Specific Objective (Data Need)	Data Type	Sampling/Analysis Activity	Analytical Level	Data Use
<b>Establish the presence or absence of contaminants</b>	Soil gas, HPGe, soil and groundwater data	For each IHSS, conduct HPGe radiation survey, soil gas survey, collect surface soil samples, subsurface soil samples, and groundwater samples, and asphalt samples, as necessary	II for HPGe radiation survey, IV for conventional analytes, & V for radiological analytes	<ul style="list-style-type: none"> <li>Contaminant source and multi-media characterization</li> </ul>
<b>Characterize the environmental setting of each IHSS</b>				
Subsurface stratigraphy and characteristics of subsurface materials	Geologic description	Evaluate applicability of existing data from adjoining IHSS's, drill boreholes and log subsurface materials	I	<ul style="list-style-type: none"> <li>Soil and Subsurface Characterization</li> </ul>
Depth to groundwater	Water level data	Water level data from existing wells, piezometers and newly installed boreholes	I	<ul style="list-style-type: none"> <li>Subsurface Characterization</li> </ul>
Groundwater flow regime	Water level data and aquifer tests	Evaluate applicability of newly developed aquifer data from adjoining Operable Units	I	<ul style="list-style-type: none"> <li>Aquifer Characterization</li> </ul>
Vadose water flow regime	Soil moisture data and matric potential measurements	Evaluate applicability of newly developed vadose zone data from STP vadose characterization and the OU2 vadose study	I	<ul style="list-style-type: none"> <li>Vadose Zone Characterization</li> </ul>
<b>Characterize the nature and extent of contamination</b>				
Affected media including location, concentration, type, physical state, and quantity of contaminants	Surface water, soil and groundwater data	For each IHSS, conduct HPGe radiation survey, soil gas survey, collect surface soil samples, subsurface soil samples, and groundwater samples, and asphalt samples, as necessary	IV for conventional analytes and V for radiological analytes	<ul style="list-style-type: none"> <li>Site Characterization</li> <li>Evaluation of Remedial Alternatives</li> <li>Risk Assessment</li> </ul>

**Table 5.1 Phase I RFI/RI Analytical Data Quality Objectives - continued**

<b>Specific Objective (Data Need)</b>	<b>Data Type</b>	<b>Sampling/Analysis Activity</b>	<b>Analytical Level</b>	<b>Data Use</b>
<b>Assess fate and transport of contaminants</b>	Soil and aquifer physical parameters	Evaluate applicability of newly developed aquifer data from adjoining Operable Units and vadose zone data from STP vadose characterization and the OU2 vadose study	<b>I</b>	• Risk Assessment
<b>Assess risk to human health and environment</b>	Data types indicated above	Synthesis of RFI/RI data	<b>I</b>	• Risk Assessment
<b>Identify applicable remedial measures</b>	Data types indicated above	Synthesis of RFI/RI data	<b>I</b>	• Evaluation of Remedial Alternatives

- **Engineering Design of Alternatives** - data are used in the remedial design process to evaluate the performance of various remedial technologies;
- **Monitoring During Remedial Action** - after remedial actions are implemented, data are used to assess their effectiveness; and
- **Correlation of Environmental Contamination to Responsible Party(s)** - data are used to link wastes detected in the environment to wastes known to be onsite.

Data uses specific to RFI/RI Phase I sampling and analysis activities for OU13 are listed in Table

5.1.

#### 5.1.2.2 Identify Data Types

Data types required for the OU13 RFI/RI are: air quality, soil engineering/geotechnical, soil-gas, soil chemistry, aquifer parameters, and groundwater chemistry. Table 5.1 provides additional information on the types of data that will be collected.

#### 5.1.2.3 Identify Data Quality Needs

The level of data quality required for OU13 RFI/RI activities is based upon the following factors: appropriate analytical levels, potential contaminants that may be present, level of concern and required detection limit. Each of these factors is discussed below.

Appropriate analytical levels for RFI/RI work are listed below (EPA, 1987).

- **Level I** Field portable instruments. Results are typically not compound-specific or quantitative. This analytical level is appropriate for providing real-time health and safety data and as a screening tool to indicate potentially contaminated areas.

- **Level II** Mobile laboratories and field gas chromatograph/mass spectrometer (GC/MS) units. Results may be compound-specific and quantitative depending on instrument calibration, reference standards, equipment condition, and operator capability. Real-time data may be available, or results may be produced in several hours. This analytical level is appropriate during the site characterization, evaluation of remedial alternatives, engineering design, and during site monitoring.
- **Level III** Offsite analytical laboratory. Results generally have a greater degree of analytical precision than Level II. Data may be available in 24 hours or in several days to weeks. Level III is an appropriate level for some phases of site characterization, evaluation of remedial alternatives, engineering design, responsible party determination, and during site monitoring. Level III may be appropriate for risk assessment depending on the outcome of RFP policy decisions.
- **Level IV** EPA Contract Laboratory Program methods are required. The analytical precision is similar to that of Level III, but stringent quality assurance and quality control protocol are formally documented. Laboratory turn-around time for reporting analytical results are similar to those described for Level III.
- **Level V** Offsite analytical laboratory using non-standard methods. Analytical method development or modification is required, and analytical precision and reporting schedules may vary according to the method.

Analytical Level I, II, IV and V will be used during implementation of the OU13 RFI/RI. The analytical methods that will be used are those specified in the EG&G Rocky Flats General Radiochemistry and Routine Analytical Services Protocol (GRRASP), Parts A and B.

Potential contaminants have been identified based upon their toxicity, persistence in the environment, and frequency of occurrence. The potential contaminants present are listed in Table 5.2, but the list is expected to evolve as additional data become available.

Table 5.2

## POTENTIAL CONTAMINANTS PRESENT IN OU13

IHSS Number	Potential Contaminants Present
117.1	plutonium 239/240, radium 226, radium 228, tritium, uranium 233/234, uranium 235, uranium 238, acetone, cadmium, copper, toluene, benzene, carbon disulfide, ethylbenzene, and xylenes
117.2	plutonium 239/240, radium 226, radium 228, uranium 233/234, uranium 235, uranium 238, tritium, arsenic, cadmium, copper, chromium, lead, mercury, 1,1,1-trichloroethane, 1,1,2,2-tetrachloroethene, 1,1-dichloroethane, 1,1,-dichloroethene, 1,2 dichloroethene, tetrachloroethene, trichloroethene, 2-butanone, toluene, xylenes, and acetone
117.3	plutonium 239/240, oils, and solvents
128	plutonium 239/240, radium 226, radium 228, uranium 233/234, uranium 238, carbon disulfide, and acetone
134	plutonium 239/240, radium 226, uranium 233/234, uranium 235, uranium 238, arsenic, copper, lead, lithium, magnesium, zinc, acetone, toluene, total petroleum hydrocarbons, and solvents
148	plutonium 239/240, radium 226, radium 228, uranium 233/234, uranium 235, uranium 238, tritium, and nitrates
152	total petroleum hydrocarbons
157.1	uranium 233/234, uranium 238, PCE, acetone, chloroform, 1,1,1-tetrachloroethane, 1,1-dichloroethane, tetrachloroethene, chloride, beryllium, lead, and mercury
158	plutonium 239/240, radium 226, radium 228, tritium, uranium 233/234, uranium 235, uranium 238, arsenic, chromium, lead, mercury, cadmium, copper, toluene, benzene, carbon disulfide, acetone, ethylbenzene, xylene, 1,1,1-trichloroethane, 1,1,2,2-tetrachloroethene, 1,1-dichloroethane, 1,1,-dichloroethene, 1,2 dichloroethene, tetrachloroethene, trichloroethene, 2-butanone, and xylenes
171	plutonium 239/240, radium 226, radium 228, uranium 233/234, uranium 238, carbon disulfide, and acetone
186	gross alpha, gross beta, americium 241, plutonium 239/240, radium 226, uranium 233/234, uranium 235, uranium 238, acetone, benzene, carbon disulfide, ethylbenzene, toluene, xylenes, chloride, and sulfate
190	sodium hydroxide, sulfate, and aluminum
191/169	hydrogen peroxide

Levels of concern are based upon available health standards and are expressed as contaminant-specific concentration ranges that serve as guidelines for selecting analytical methods, detection limits and in determining the boundaries of field investigations.

Detection limit requirements take into account the levels of concern, RFP chemical specific Benchmarks in lieu of Applicable or Relevant and Appropriate Requirements (ARARs), and DQOs specified in the RFP Site-Wide Quality Assistance Project Plan (RFP, QAPjP, 1991). Site-specific ARARs will be developed as the initial step in the OU13 corrective measures study. Detection limits are listed in Table 5.3.

#### 5.1.2.4 Identify Data Quantity Needs

Data quantity needs are based on a review of the available environmental data and on the data uses previously described. Field sampling density is based on a subjective evaluation supported by statistical evaluation. The subjective evaluation includes review of site features to ensure that data are collected at each location where contamination is most likely to have been released.

To ensure that a sufficient quantity of data are collected, the FSAP specifies a three stage approach to data collection. The purpose of Stage 1 is the collection of screening data to efficiently guide data collection in Stages 2 and 3. The purpose of Stage 2 is to confirm the contamination or lack of contamination indicated by Stage 1, and the purpose of Stage 3 is to complete the collection of data needed for the RFI/RI investigation. Since the data quantity needed in Stage 2 is based on the results of Stage 1 and the data quantity needed in Stage 3 is based on the results of Stage 1 and Stage 2, only Stage 1 data needs will be completely specified in this Work Plan.

The FSAP specifies the sampling density of each IHSS for Stage 1. The evaluation of sampling density was based on reducing the probability of failing to detect a contaminated area to a level that supports the data uses. Triangular grids will be used because they are likely to provide more



Table 5.3

**ANALYTICAL PARAMETER AND DETECTION/QUANTITATION LIMITS  
FOR SAMPLING ACTIVITIES AT OU13**

**TARGET COMPOUND LIST VOLATILES**

	Water Limits (ug/L)	Soil Limits ug/Kg
Chloromethane	10	10
Bromomethane	10	10
Vinyl Chloride	10	10
Chloroethane	10	10
Methylene Chloride	5	5
Acetone	10	10
Carbon Disulfide	5	5
1,1-Dichloroethene	5	5
1,1-Dichloroethane	5	5
1,2-Dichloroethene (total)	5	5
Chloroform	5	5
1,2-Dichloroethane	1	5
2-Butanone	10	10
1,1,1-Trichloroethane	5	5
Carbon Tetrachloride	5	5
Vinyl Acetate	10	10
Bromodichloromethane	5	5
1,2-Dichloropropane	5	5
cis-1,3-Dichloropropene	5	5
Trichloroethene	5	5
Dibromochloromethane	5	5
1,1,2-Trichloroethane	5	5
Benzene	5	5
trans-1,2-Dichloropropene	5	5
Bromoform	5	5
4-Methyl-2-pentanone	10	10
2-Hexanone	10	10

Detection limits are identified in the QAPjP.

EPA Contract Laboratory Method for TCL volatiles will be used unless noted otherwise.

## TARGET COMPOUND LIST VOLATILES

	Water Limits (ug/L)	Soil Limits ug/Kg
Tetrachloroethene	5	5
Toluene	5	5
1,1,2,2-Tetrachloroethane	5	5
Chlorobenzene	5	5
Ethyl Benzene	5	5
Styrene	5	5
Xylenes (total)	5	5

## TARGET COMPOUND LIST SEMI-VOLATILES

Phenol	10	330
bis(2-Chloroethyl)ether	10	330
2-Chlorophenol	10	330
1-3-Dichlorobenzene	10	330
1-4-Dichlorobenzene	10	330
Benzyl Alcohol	10	330
1-2-Dichlorobenzene	10	330
2-Methylphenol	10	330
bis(2-Chloroisopropyl)ether	10	330
4-Methylphenol	10	330
N-Nitroso-Dipropylamine	10	330
Hexachloroethane	10	330
Nitrobenzene	10	330
Isophorone	10	330
2-Nitrophenol	10	330
2,4-Dimethylphenol	10	330
Benzoic Acid	50	1600
bis(2-Chloroethoxy)methane	10	330
2,4-Dichlorophenol	10	330
	Water Limits (ug/L)	Soil Limits (ug/K)
1,2,4-Trichlorobenzene	10	330
Naphthalene	10	330
4-Chloroaniline	10	330

Detection limits are identified in the QAPjP.

EPA Contract Laboratory Method for TCL volatiles will be used unless noted otherwise.

Table 5.3 - Continued

**ANALYTICAL PARAMETER AND DETECTION/QUANTITATION LIMITS  
FOR SAMPLING ACTIVITIES AT OU13**

TARGET COMPOUND LIST SEMI-VOLATILES		
Hexachlorobutadiene	10	330
4-Chloro-3-methylphenol	10	330
2-Methylnaphthalene	10	330
Hexachlorocyclopentadiene	10	330
2,4,6-Trichlorophenol	10	330
2,4,5-Trichlorophenol	50	1600
2-Chloronaphthalene	10	330
2-Nitroaniline	50	1600
Dimethylphthalate	10	330
Acenaphthylene	10	330
2,6-Dinitrotoluene	10	330
3-Nitrophenol	50	1600
Acenaphthene	10	330
2,4-Dinitrophenol	50	1600
4-Nitrophenol	50	1600
Dibenzofuran	10	330
2,4-Dinitrotoluene	10	330
Diethylphthalate	10	330
4-Chlorophenol Phenyl ether	10	330
Fluorene	10	330
4-Nitroaniline	50	1600
4,6-Dinitro-2-methylphenol	50	1600

TARGET COMPOUND LIST SEMI-VOLATILES - continued

	Water Limits (ug/L)	Soil Limits (ug/Kg)
N-nitrosodiphenylamine(1)	10	330
4-Bromophenyl-Phenyl ether	10	330
Phenanthrene	10	330

Detection limits are identified in the QAPjP.

EPA Contract Laboratory Method for TCL volatiles will be used unless noted otherwise.

Table 5.3 - Continued

ANALYTICAL PARAMETER AND DETECTION/QUANTITATION LIMITS  
FOR SAMPLING ACTIVITIES AT OU13

Anthracene	10	330
Di-n-butylphthalate	10	330
Flouranthene	10	330
Pyrene	10	330
Butyl Benzlyphthalate	10	330
3,3'-Dichlorobenzidine	20	660
Benzo(a)anthracene	10	330
Chrysene	10	330
bis-(2-ethylhexyl)phthalate	10	330
Di-n-octyl Phthalate	10	330
Benzo(b)flouranthene	10	330
Benzo(k)flouranthene	10	330
Benzo(a)pyrene	10	330
Indeno(1,2,3-cd)pyrene	10	330
Dibenz(a,h)anthracene	10	330
Benzo(g,h,i)perylene	10	330

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Detection limits are identified in the QAPjP.

EPA Contract Laboratory Method for TCL volatiles will be used unless noted otherwise.

Table 5.3 - Continued

**ANALYTICAL PARAMETER AND DETECTION/QUANTITATION LIMITS  
FOR SAMPLING ACTIVITIES AT OU13**

**TARGET ANALYTE LIST METALS**

	Water Limits (ug/L)	Soil Limits (mg/Kg)
Aluminum	200	40
Antimony	60	12
Arsenic	10	2
Barium	200	40
Beryllium	5	1
Cadmium	5	1
Calcium	5000	2000
Chromium	10	2
Cobalt	50	10
Copper	25	5
Cyanide	5	10
Iron	100	20
Lead	3	1
Magnesium	5000	2000
Manganese	15	3
Mercury	.2	.2
Nickel	40	8
Potassium	5000	2000
Selenium	5	1
Silver	10	2
Sodium	10	2
Thallium	10	2
Vanadium	50	10
Zinc	20	4
Lithium	100	20

Detection limits are identified in the QAPjP.

EPA Contract Laboratory Method for TCL volatiles will be used unless noted otherwise.

Table 5.3 - Continued

ANALYTICAL PARAMETER AND DETECTION/QUANTITATION LIMITS  
FOR SAMPLING ACTIVITIES AT OU13

## SOIL GAS SAMPLES

Parameter	Detection Limit (ug/l)
Acetone	1
Benzene	1
Carbon disulfide	1
Carbon tetrachloride	1
Chloroform	1
Dichloromethane	1
Ethylbenzene	1
Methylene chloride	1
PCE	1
TCE	1
Toluene	1
Xylenes (total)	1
1,1-DCA	1
1,1,1-TCA	1
1,2-DCA	1
2-Butanone	1

Note: Detection limits are a function of the detector type and injection volume. Thus, the detection limit may vary. Target detection limits will be at or below the listed values.

information for a given number of samples than a square grid. Two grid spacings are specified - 20 feet and 40 feet. A statistical method described by Gilbert, 1987, indicates that the probability of not finding a elliptical area with long and short axis of 32.2 feet and 15.6 feet with a triangular grid spacing of 20 feet is 10 percent. For a grid spacing of 40 feet, the ellipse is 64.4 by 32.2 feet.

#### 5.1.2.5 Evaluate Sampling/Analysis Options

RFI/RI data collection and analysis for OU13 will utilize a graduated approach in which analytical Level I and Level II field screening techniques will be used to focus subsequent data collection and analysis for analytical Levels IV and V. The sampling/analysis options selected are based upon their ability to obtain data that is consistent with known site conditions.

Field screening techniques will be used whenever possible to reduce waste generated during sample collection, minimize delays that can result when more exacting analytical methods are used, and to minimize worker exposure. Analytical Level I and Level II field screening will assess both radiochemical and organic chemical contamination during stage one of the FSAP. Radiological surveys using a High Purity Germanium detector (HPGe) will be conducted to identify areas of radiochemical contamination that may require further investigation. Field methods for use of the HPGe are presently being finalized and a standard operating procedure will be incorporated in the Environmental Management Radiological Guidelines Manual (RFP-EMD, 1991a). Soil-gas surveys utilizing a portable GC will be used to identify areas of organic chemical contamination and to direct further sampling efforts. Data collection procedures will be those specified in Environmental Management Division Manual 5-21000, Volume III, Geotechnical (RFP-EMD, 1992a). Photoionization detectors will be employed for health and safety purposes.

As part of the Stage 1 sampling program, surface soil samples will be collected at specific IHSSs on a sampling grid sufficient to support a human health risk assessment. These samples will be analyzed for TAL metals at some IHSSs and specific metals at other IHSSs. In addition, a subset of these samples will be analyzed for gamma-emitting radionuclides with an onsite laboratory HPGe. A minimal number of splits of these samples will also be submitted to a radiochemistry laboratory for analysis of plutonium 239 and 240, americium 241, uranium 238, uranium 233/234, tritium, strontium 89/90, strontium 90, cesium 137, radium 226, radium 228, gross alpha and gross beta. At specific IHSSs asphalt samples will also be collected and analyzed with a laboratory HPGe. Laboratory analytical methods will conform to those referenced in the GRRASP; these methods meet the criteria for analytical Levels IV and V. Field data collection will be in accordance with Environmental Management Division Manual 5-2000, Volume III, Geotechnical (RFP-EMD, 1992a). Analytical methods for the laboratory HPGe will be developed prior to its use. A limited number of boreholes will also be drilled during Stage 1 at IHSSs where subsurface contamination with radionuclides and/or metals may be present at depth. The samples from these boreholes will be analyzed for TAL metals, and specific anions at an offsite laboratory and for radionuclides with a laboratory HPGe.

After Stage 1 sampling is complete, a technical memorandum will be prepared. The technical memorandum will evaluate the results of Stage 1 sampling and recommend locations for installing boreholes and collecting surface scrape samples. Surficial soil sampling results will be reported in a later technical memorandum, prior to the commencement of Stage 3 sampling.

Surface scrape samples will be collected during Stage 2 of the FSAP at borehole locations. A scrape sample will be collected at a depth of approximately four inches below the base material that underlies the asphalt pavement. Surface scrape samples will be analyzed for TCL semi-volatile compounds, TAL metals, plutonium 239 and 240, americium 241, uranium 238, uranium 235, uranium 233/234, tritium, strontium 89/90, strontium 90, cesium 137, radium 226, radium



228, gross alpha, and gross beta. Analytical methods will conform to those referenced in the GRRASP; these methods meet the criteria for analytical Level III through V. Field data collection will be in accordance with Environmental Management Division Manual 5-21000, Volume III, Geotechnical (RFP-EMD, 1992a).

Soil samples will be collected from boreholes during Stage 2 of the FSAP to assess contaminant types and distribution. Two boreholes may be drilled in each IHSS, one at a hot spot identified by the radiation survey and one at a hot spot identified by the soil gas survey. If no hot spots are identified within an IHSS, a single borehole will be installed at the most likely source of contamination; for example, areas with stained soil or areas believed to be contaminated based on operating history. An exception to this method of locating boreholes will be made for IHSS 152. Three boreholes will be installed around the berm surrounding the storage tank, one upgradient and two downgradient. Samples will be analyzed for TCL volatile compounds, TCL semi-volatile compounds, TAL metals, plutonium 239 and 240, americium 241, uranium 238, uranium 235, uranium 233/234, tritium, strontium 89/90, strontium 90, cesium 137, radium 226, radium 228, gross alpha, and gross beta. Analytical Level III will be used for the volatile, semi-volatile and metals analyses. Analytical Level V will be used for the radiochemical analyses. Field data collection will be in accordance with Environmental Management Division Manual 5-21000, Volume III, Geotechnical (RFP-EMD, 1992b).

Alluvial groundwater samples will be collected from all existing piezometers and monitor wells in and immediately surrounding OU13 during stage one of the FSAP. During stage two of the FSAP, alluvial groundwater samples will be collected at the time boreholes are drilled using the Hydropunch® method or equivalent. If contamination is confirmed by the soil or groundwater samples, one monitoring well will be located upgradient of the affected IHSS and one monitoring well will be located downgradient of the affected IHSS. Samples will be analyzed for TCL volatiles, TCL semi-volatiles, TAL metals, plutonium 239 and 240, americium 241, uranium 238,

uranium 235, uranium 233/234, tritium, strontium 89/90, strontium 90, cesium 137, radium 226, radium 228, gross alpha and gross beta. Quarterly groundwater data collection from monitoring wells will be conducted as Part of the RFP site-wide monitoring program. Analytical Level IV (CLP protocol) and Level V (for radiochemicals) will be used for groundwater sample analysis. Groundwater sampling and measurement of field parameters will be conducted in accordance with procedures specified in the FSAP.

All data collection field records will be handled in accordance with the quality control procedures specified in Environmental Management Division Manual 521000, Volume I, Field Operations (RFP-EMD, 1992c).

#### 5.1.2.6 Review of PARCC Parameter Information

PARCC parameters (precision, accuracy, representativeness, completeness, and comparability) for analytical Levels I, II, IV, and V are discussed below. Precision, accuracy and completeness goals are specified in the Quality Assurance addendum for this Work Plan.

Precision is a quantitative measure of data quality that defines the reproducibility or degree of agreement among replicate measurements of a single analyte. The closer the numerical values of the measurements are to each other, the more precise the measurements. One of methods used to estimate the precision of a method is the standard error of the estimates for the least square regression line of "measured" versus "target" concentrations (EG&G, 1991i). The primary role of this application is to characterize the precision of any analysis method under specified conditions. This allows comparison of different results produced by the same method. Analytical precision for a single analyte may be expressed as percentage of the difference between results of duplicate samples and matrix spike duplicates for a given analyte. Precision

will be determined from the results of duplicate and matrix spike duplicate analyses (EG&G, 1991i).

During the collection of data using field methods or instrumentation, precision is checked by reporting several measurements taken at one location and comparing the results. Precision will be reported as the relative percent difference for two results and as the standard deviation for three or more results. Sample collection precision shall be measured in the laboratory with the analysis of field replicates and laboratory duplicates (EG&G, 1991i). Analytical precision will be achieved by adhering to the analytical methods contained in the GRRASP. Sampling precision will be achieved by conformance the procedures specified in the Environmental Management Division's Operating Procedure manuals referenced above.

Accuracy can be expressed in terms of completeness and bias. Accuracy is a quantitative measure of data quality that refers to the degree of difference between measured or calculated values and the true value. The closer to the true value, the more accurate measurement. One of the measures of analytical accuracy is expressed as a percent recovery of a spike or tracer which has been added to the environmental sample at a known concentration before analysis (ERP, 1991). While it is not feasible to totally eliminate sources of error that may reduce accuracy, the OU13 Work Plan attempts to minimize error by using standardized analytical methods and field procedures.

Representativeness is a qualitative parameter that expresses the degree to which sample data accurately represent a characteristic of a population, parameter variations at a sampling point, or an environmental condition (ERP, 1991). Representative data will be obtained by using both biased and unbiased methods of selecting sample locations. Biased methods will employ existing data in areas known to be contaminated to determine the degree of contamination. Unbiased methods such as grid sampling will be used to determine both the nature and extent of

contamination. Field work will be conducted according to standard operating procedures, further aiding the collection of representative data.

Completeness is a quantitative measure of data quality expressed as the percentage of valid or acceptable data obtained from a measurement system. The objectives of the field sampling program are to obtain samples for all analyses required at each individual site, to provide sufficient sample material to complete those analyses, and to produce QC samples that represent all possible contamination situations such as potential contamination during sample collection, transportation, or storage (EG&G, 1991i).

Comparability is a qualitative parameter describing the confidence with which one data set may be compared to another (EPA, 1987). The standard laboratory methods of the GRRASP and standard operating procedures for conducting field work will allow for one to one comparability of OU13 RFI/RI data to other work conducted in conformance with those same standards.

### 5.1.3 Stage 3 - Design Data Collection Program

Stage three of the DQO process compiles the various elements of Stages one and two into a cohesive data collection program for the OU13 RFI/RI. To this end, a Field Sampling and Analysis Plan and Quality Assurance/Quality Control Plan have been developed and are included as Sections 6 and 10, respectively, of this Work Plan. The results of the DQO process have been distilled into a detailed list (Table 6.1) of the number and type of samples to be collected, their location, and analytical methods.

**ROCKY FLATS PLANT**  
**Phase I RFI/RI Work Plan**  
**Operable Unit 13**  
**100 Area**


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**Date**

## **6.0 FIELD SAMPLING AND ANALYSIS PLAN**

The purpose of this section of the work plan is to develop a Field Sampling and Analysis Plan (FSAP) that will address the data needs of the Phase I RFI/RI and describe the work required to fulfill the data quality objectives. Section 6.1 presents the objectives of the OU13 RFI/RI. Section 6.2 summarizes site background information and rationale for the sampling, analysis, and other data collection activities. Section 6.3 discusses the field data collection program for each site. Section 6.4 describes field sampling procedures and equipment, and Section 6.5 describes the analytical program including sample designation, analytical requirements, sample containers and preservation, and sample handling and documentation. Section 6.6 describes QA/QC procedures for the OU13 RFI/RI.

### **6.1 OU13 RFI/RI OBJECTIVES**

The objective of this FSAP is to provide environmental measurement data of sufficient detail and quality to meet the intended use of the data. The data generated through implementation of this FSAP will be used to:

- Establish the presence or absence of contaminants;
- Characterize the environmental setting of each IHSS;
- Characterize the nature and extent of contamination;

- Assess risk to human health and environment; and
- Support selection of remedial action alternatives.

This FSAP is designed to characterize contamination of soils and groundwater that may have resulted from historical releases at OU13 IHSSs. Air, surface water, and sediment will be characterized using data collected under other sitewide programs unless additional data are determined to be required for these media (see Section 6.2.2).

## 6.2 BACKGROUND AND SAMPLING RATIONALE

### 6.2.1 Background

Available information regarding potential contamination associated with OU13 includes limited IHSS histories, stratigraphic well logs, water level data, and analytical data for air, groundwater, surface water, sediment, and borehole samples collected within and around OU13. This information is described in detail in Section 2.0 of this work plan.

As stated in Section 2.0, the available analytical data indicate the presence of contamination at several IHSSs but are not of a sufficient quantity or quality to allow a determination of the source(s) of contamination or the nature and extent of contamination. The existing data are currently being validated to the extent possible. The use of these data in making RFI/RI decisions will be continually evaluated as the validation process continues.

### 6.2.2 Sampling Rationale

The rationale for Phase I sampling activities is based on a staged approach (Table 6.1). Stage 1 will address the presence of contamination and will involve primarily screening-level surveys. Stage 2 will confirm the results of Stage 1 and verify the presence of contamination in the vadose zone and/or groundwater. Stage 3, if necessary, will address the potential migration of contaminants from each IHSS. Figures 6-1A through 6-1D present sampling decision trees for each IHSS identifying investigation stages, types of sampling, and sampling decisions. Section 6.3 presents the planned sampling activities at each IHSS. Table 6.2 compares the planned sampling activities with those required by the IAG. The procedures that will be used in each type of sampling are listed in Table 6.3 and discussed in Section 6.4.

During all stages of the investigation, any anomalies detected will be investigated until the anomalies are completely mapped. For example, if soil gas anomalies continue beyond the present IHSS boundaries, additional soil gas samples will be collected and analyzed outside the IHSS boundaries until the anomalies are completely mapped or the boundary of a neighboring IHSS is encountered. If the adjoining IHSS is located in another operable unit, sampling within that IHSS will be coordinated with the appropriate Operable Unit Manager.

Because the existing data do not provide direct evidence of contamination at the OU13 IHSSs, Stage 1 sampling activities are designed to detect contamination at each IHSS primarily using screening-level surveys. These surveys will provide a preliminary assessment of the nature of contamination present, and they will provide information on a real-time basis that is needed for

TABLE 6.1 (Sheet 1 of 3)  
PHASE I INVESTIGATION STAGES FOR OU13

Activity	Purpose	Location	Sample Number
<b><u>Stage 1</u></b>			
Visual Inspection	Identify areas of visible contamination. Assess access problems.	Entire IHSS area.	None.
HPGe Radiological Survey	Identify areas of anomalous gamma ray radiation readings.	Entire IHSS area.	IHSS dependent.
Soil Gas Survey	Locate VOC anomalies	Entire IHSS area - grid spacing IHSS dependent.	IHSS dependent.
Surficial Soil Sampling	Assess radiological and nonradiological contamination. Confirm HPGe results.	Entire IHSS area - locations IHSS dependent.	IHSS dependent.
Vertical Soil Profiles	Aid interpretation of HPGe survey.	Locations selected after HPGe survey completed.	To be determined.
Soil Borings	Assess radiological and nonradiological contamination at IHSSs where subsurface contamination may be present.	IHSS dependent.	IHSS dependent.
Asphalt/Concrete Samples	Determine the presence or absence of radionuclides.	IHSS dependent.	IHSS dependent.

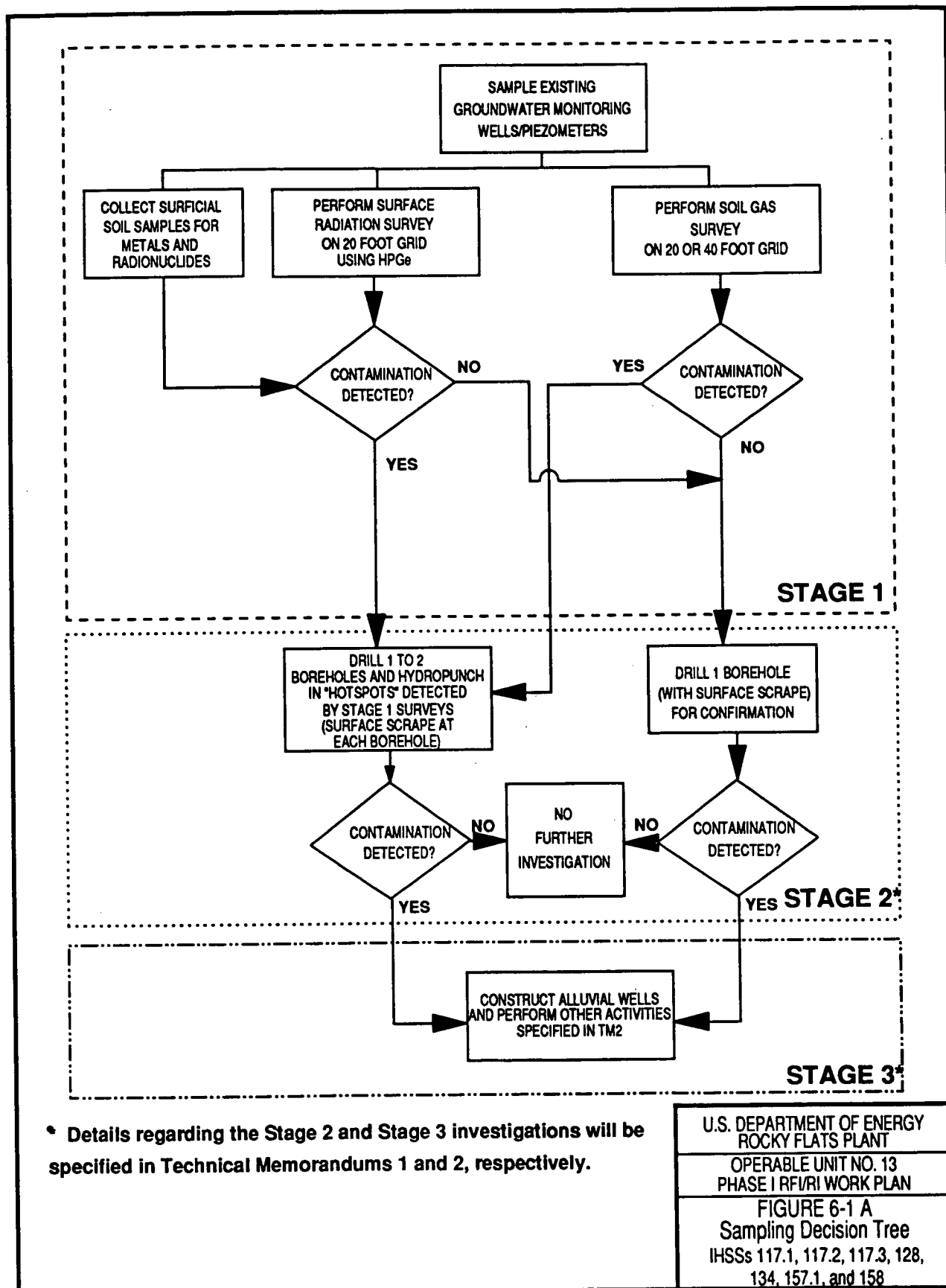


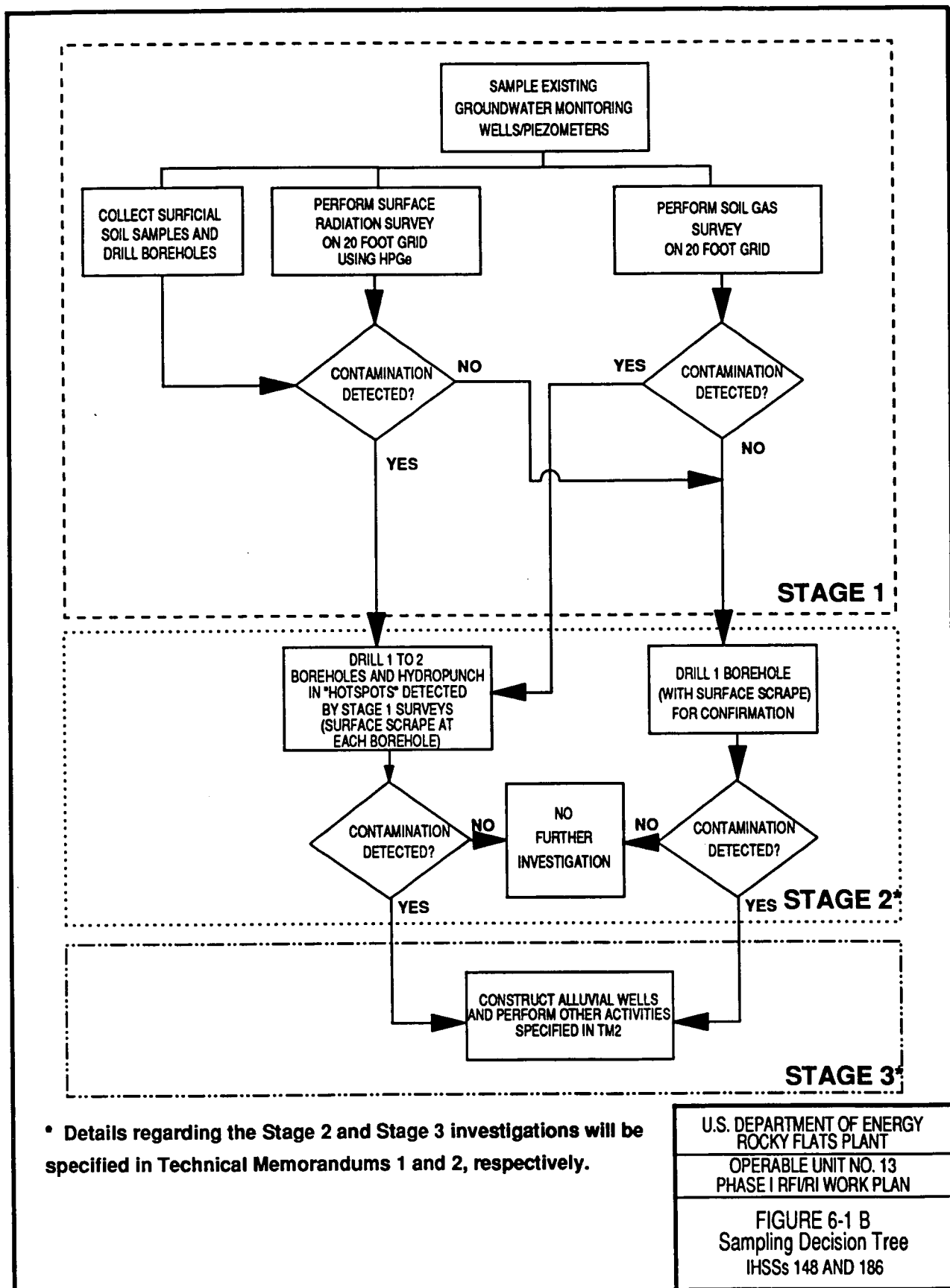
TABLE 6.1 (Sheet 2 of 3)  
PHASE I INVESTIGATION STAGES FOR OU13

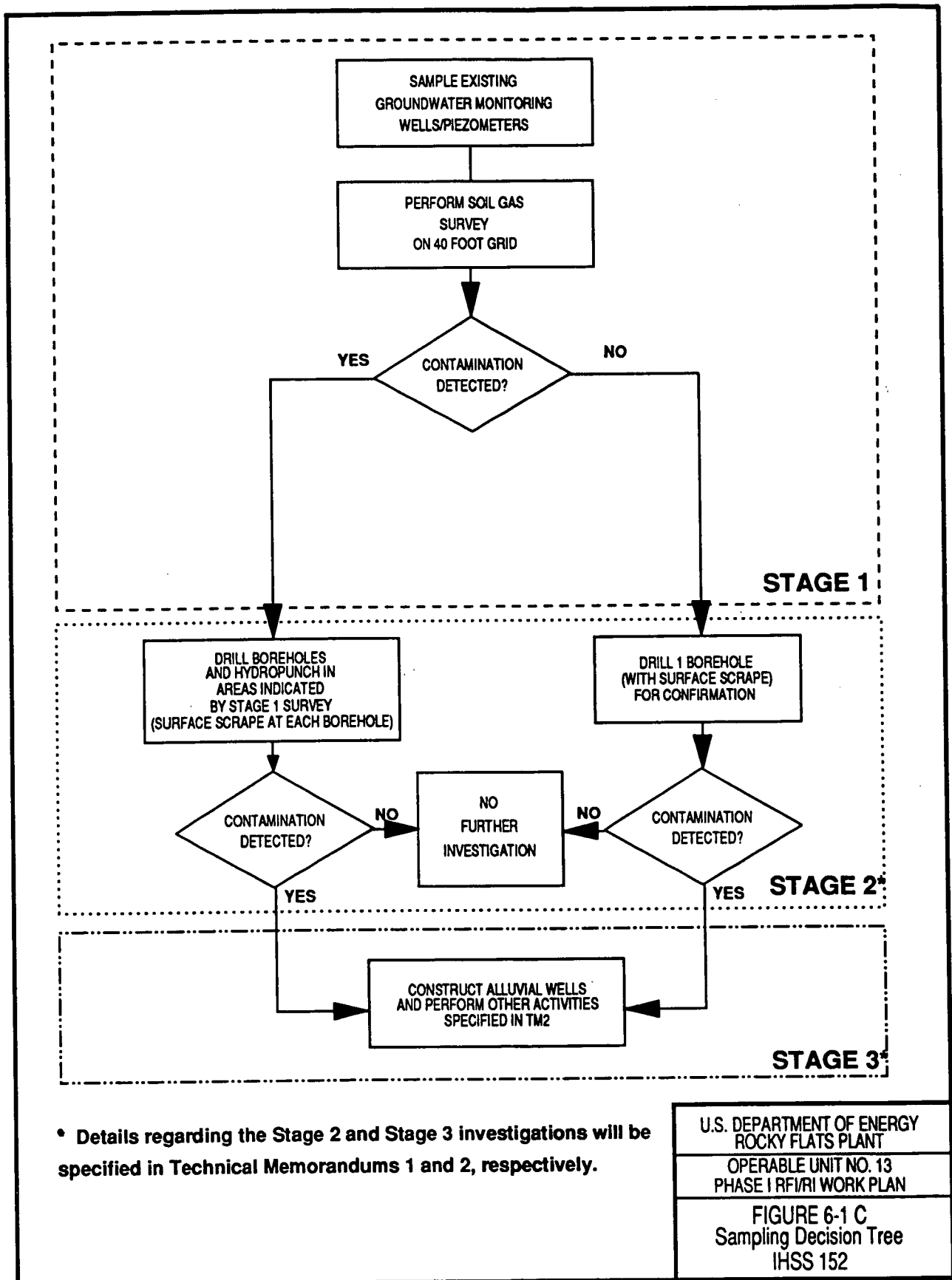
Activity	Purpose	Location	Sample Number
<b><u>Stage 1 (continued)</u></b>			
Sampling of Existing Groundwater Monitoring Wells and Piezometers	Assess radiological and nonradiological contamination. Begin characterization of groundwater conditions.	IHSS dependent.	IHSS dependent.
Sampling of Water in Sump	Assess potential contamination of surface water.	IHSS 171.	One.
TECHNICAL MEMORANDUM 1			
<b><u>Stage 2</u></b>			
Surface Scrapes	Determine presence/absence of contaminants at borehole locations.	IHSS dependent (at borehole locations).	To be determined.
Soil Borings	<p>a. Sample anomalies identified by HPGe and soil gas surveys or confirm absence of contamination.</p> <p>b. Characterize subsurface vadose zone conditions and contamination.</p>	<p>IHSS dependent - at a minimum, one at most likely spot to be contaminated in IHSSs where no contamination was detected by screening surveys or one at the maxima detected by the HPGe and/or soil gas surveys in IHSSs where contamination was detected by screening surveys (locations to be specified in technical memorandum).</p>	To be determined - to be specified in technical memorandum.

TABLE 6.1 (Sheet 3 of 3)  
PHASE I INVESTIGATION STAGES FOR OU13

Activity	Purpose	Location	Sample Number
<u>Stage 2 (continued)</u>  Groundwater Sampling with Hydropunch®, or equivalent  TECHNICAL MEMORANDUM 2	Assess groundwater contamination.	IHSS dependent - at a minimum, samples to be taken in boreholes drilled at maxima detected by screening surveys (locations to be specified in technical memorandum).	To be determined - to be specified in technical memorandum.
<u>Stage 3</u>  Soil Borings  Monitoring Well Installation and Sampling and/or Sampling with Hydropunch®, or equivalent  Tensiometer Nests or equivalent and Leachability Tests	Assessment of contaminants in the subsurface.  Assess nature and extent of contamination of groundwater.  Determine transport characteristics.	To be determined - to be specified in technical memorandum.  To be determined - to be specified in technical memorandum.  To be determined - to be specified in technical memorandum.	To be determined - to be specified in technical memorandum.  To be determined - to be specified in technical memorandum.  To be determined - to be specified in technical memorandum.







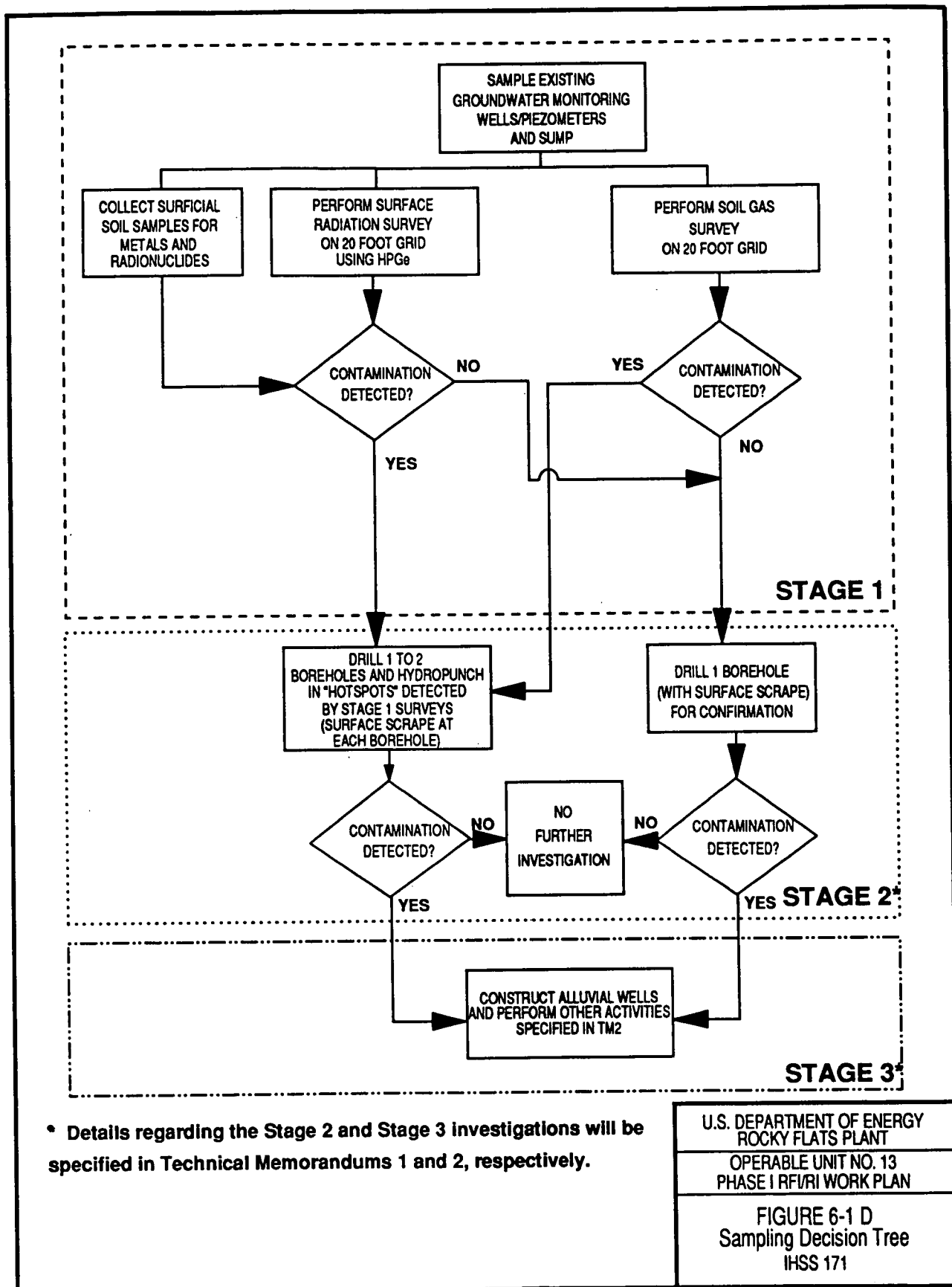


TABLE 6.2 (Sheet 1 of 8)  
OU13 IAG REQUIREMENTS\*/FSP COMPARISON

IAG*			FSP		
IHSS Number	Activity	No. of Samples/Borings	Activity	No. of Samples/Borings	Rationale
117.1, 117.3	Provide documentation of materials/chemicals stored	NA	Provide documentation of materials/chemicals stored*	NA	In Agreement - Information Provided in Section 2.0
			Visual Inspection	NA	Identify visible contamination
			HPGe Radiological Survey	20' grid spacing	Investigate soil contamination indicated by Well P214689
	Soil Gas Survey	100' grid spacing	Soil Gas Survey	20' grid spacing	Improved Coverage - additional analytes added based on available data
			Surficial Soil Sampling	7 - 117.1 5 - 117.3	Investigate soil contamination with metals and radionuclides - confirm HPGe survey
			Vertical Soil Profiles	TBD	Aid interpretation of HPGe survey
			Sample Existing Wells/Piezometers	2	Provide cost-effective information regarding groundwater conditions
	Boreholes in Soil Gas Plumes	TBD	Boreholes in Soil Gas and Radiation Anomalies	TBD	In Agreement
	Boreholes (confirmation of soil gas)	TBD	Boreholes (confirmation of soil gas and radiation surveys)	TBD	In Agreement
	Monitoring Wells	TBD	Monitoring Wells	TBD	In Agreement
			Nested Tensiometers	TBD	Increased Coverage

\* Per modifications outlined in letter from G.W. Baughman, CDH, to F. Lockhart, DOE, dated February 10, 1992.

NA = Not applicable      TBD = To be determined

\* This activity was performed during the preparation of this Work Plan.

TABLE 6.2 (Sheet 2 of 8)  
OU13 IAG REQUIREMENTS\*/FSP COMPARISON

IHSS Number	IAG*		FSP		Rationale
	Activity	No. of Samples/Borings	Activity	No. of Samples/Borings	
117.2			Visual Inspection	NA	Identify visible contamination
			HPGe Radiological Survey	20' grid spacing	Investigate possible contamination indicated by IHSS history
	Soil Gas Survey	100' grid spacing	Soil Gas Survey	20' grid spacing	Improved Coverage - additional analytes added based on available data
			Surficial Soil Sampling	5	Investigate soil contamination with metals and radionuclides - confirm HPGe survey
			Vertical Soil Profiles	TBD	Aid interpretation of HPGe survey
			Asphalt Sampling	5	Investigate contamination of asphalt
			Sample Existing Wells/Piezometers	2	Provide cost-effective information regarding groundwater conditions
	Boreholes in Soil Gas Plumes	TBD	Boreholes in Soil Gas and Radiation Anomalies	TBD	In Agreement
	Boreholes (confirmation of soil gas)	TBD	Boreholes (confirmation of soil gas and radiation surveys)	TBD	In Agreement
			Nested Tensiometers	TBD	Increased Coverage
	Monitoring Wells	TBD	Monitoring Wells	TBD	In Agreement

\* Per modifications outlined in letter from G.W. Baughman, CDH, to F. Lockhart, DOE, dated February 10, 1992.

NA = Not applicable      TBD = To be determined

\* This activity was performed during the preparation of this Work Plan.



TABLE 6.2 (Sheet 3 of 8)  
OU13 IAG REQUIREMENTS\*/FSP COMPARISON

IAG*			FSP		
IHSS Number	Activity	No. of Samples/Borings	Activity	No. of Samples/Borings	Rationale
128, 134, 171	Reevaluate IHSS location	NA	Reevaluate IHSS location*	NA	In Agreement - Information
			Visual Inspection	NA	Identify visible contamination
	FIDLER-GM Radiological Survey	10' grid spacing	HPGe Radiological Survey	20' grid spacing	Improved Technology
	Soil Gas Survey	25' grid spacing	Soil Gas Survey	20' grid spacing 40' grid spacing over extension of IHSS 134	Improved Coverage - additional analytes added based on available data
			Surficial Soil Sampling	3 - 128,134(N) 5 - 134(S) 4 - 171	Investigate soil contamination with metals and radionuclides - confirm HPGe survey
			Vertical Soil Profiles	TBD	Aid interpretation of HPGe survey
			Asphalt Sampling (Southern portion of IHSS 134)	4	Investigate contamination of asphalt
			Sample Existing Wells/Piezometers	3 - IHSS 128 and IHSS 171 1 - IHSS 134	Provide cost-effective information regarding groundwater conditions
	Boreholes in Soil Gas Plumes	TBD	Boreholes in Soil Gas and Radiation Anomalies	TBD	In Agreement
			Monitoring Wells	TBD	Increased Coverage
			Nested Tensiometers	TBD	Increased Coverage

\* Per modifications outlined in letter from G.W. Baughman, CDH, to F. Lockhart, DOE, dated February 10, 1992.

NA = Not applicable      TBD = To be determined

\* This activity was performed during the preparation of this Work Plan.

TABLE 6.2 (Sheet 4 of 8)  
OU13 IAG REQUIREMENTS\*/FSP COMPARISON

IAG*			FSP		
IHSS Number	Activity	No. of Samples/Borings	Activity	No. of Samples/Borings	Rationale
148	Submit documentation of radiometric survey(s)	NA	Submit documentation of radiometric survey(s)*	NA	In Agreement - Information provided in Section 2.0
			Visual Inspection	NA	Identify visible contamination
	FIDLER-GM Radiological Survey	10' grid spacing	HPGe Radiological Survey	20' grid spacing	Improved Technology
			Soil Gas Survey	20' grid spacing	Investigate VOC contamination of groundwater in area
			Surficial Soil Sampling	8	Confirm HPGe results
			Vertical Soil Profiles	TBD	Aid interpretation of HPGe survey
			Asphalt Sampling	4	Investigate contamination of asphalt
			Sample Existing Wells/Piezometers	5	Provide cost-effective information regarding groundwater conditions
	Soil Borings	TBD	Boreholes in Soil Gas and Radiation Anomalies and near OPWL	TBD - 1 near OPWL	In Agreement
			Nested Tensiometers	TBD	Increased Coverage
			Monitoring Wells	TBD	Increased Coverage

\* Per modifications outlined in letter from G.W. Baughman, CDH, to F. Lockhart, DOE, dated February 10, 1992.

NA = Not applicable      TBD = To be determined

\* This activity was performed during the preparation of this Work Plan.

TABLE 6.2 (Sheet 5 of 8)  
OU13 IAG REQUIREMENTS\*/FSP COMPARISON

IHSS Number	IAG*		FSP		Rationale
	Activity	No. of Samples/Borings	Activity	No. of Samples/Borings	
152			Visual Inspection	NA	Identify visible contamination
	Soil Gas Survey	20' grid spacing	Soil Gas Survey	40' grid spacing	Grid spacing results in acceptable probability of missing area of contamination
			Sample Existing Wells/Piezometers	2	Provide cost-effective information regarding groundwater conditions
	Soil Cores/Borings	TBD	Soil Borings	TBD - minimum of 3	In Agreement
			Nested Tensiometers	TBD	Increased Coverage
			Monitoring Wells	TBD	Increased Coverage

\* Per modifications outlined in letter from G.W. Baughman, CDH, to F. Lockhart, DOE, dated February 10, 1992.

NA = Not applicable      TBD = To be determined

• This activity was performed during the preparation of this Work Plan.

TABLE 6.2 (Sheet 6 of 8)  
OU13 IAG REQUIREMENTS\*/FSP COMPARISON

IHSS Number	IAG*		FSP		Rationale
	Activity	No. of Samples/Borings	Activity	No. of Samples/Borings	
157.1	Submit documentation of radiometric survey(s)	NA	Submit documentation of radiometric survey(s)*	NA	In Agreement - Information provided in Section 2.0
			Visual Inspection	NA	Identify visible contamination
	FIDLER-GM Radiological Survey	25' grid spacing	HPGe Radiological Survey	20' grid spacing	Improved Technology
			Soil Gas Survey	20' grid spacing	Investigate VOC contamination of groundwater in area
	Surficial Soil Sampling	TBD	Surficial Soil Sampling	6	In Agreement
			Vertical Soil Profiles	TBD	Aid interpretation of HPGe survey
			Sample Existing Wells/Piezometers	3	Provide cost-effective information regarding groundwater conditions
	Soil Borings	TBD	Soil Borings	TBD	In Agreement
			Nested Tensiometers	TBD	Increased Coverage
			Monitoring Wells	TBD	Increased Coverage

\* Per modifications outlined in letter from G.W. Baughman, CDH, to F. Lockhart, DOE, dated February 10, 1992.

NA = Not applicable      TBD = To be determined

\* This activity was performed during the preparation of this Work Plan.

TABLE 6.2 (Sheet 7 of 8)  
OU13 IAG REQUIREMENTS\*/FSP COMPARISON

IHSS Number	IAG*		FSP		Rationale
	Activity	No. of Samples/Borings	Activity	No. of Samples/Borings	
158			Visual Inspection	NA	Identify visible contamination
	FIDLER-GM Radiological Survey	25' grid spacing	HPGe Radiological Survey	20' grid spacing	Improved Technology
	Soil Gas Survey	25' grid spacing	Soil Gas Survey	20' grid spacing	Increased Coverage
	Surficial Soil Sampling	TBD	Surficial Soil Sampling	6	In Agreement
			Vertical Soil Profiles	TBD	Aid interpretation of HPGe survey
			Sample Existing Wells/Piezometers	4	Provide cost-effective information regarding groundwater conditions
	Boreholes in Soil Gas Plumes	TBD	Boreholes in Soil Gas and Radiation Anomalies	TBD	In Agreement
			Nested Tensiometers	TBD	Increased Coverage
			Monitoring Wells	TBD	Increased Coverage
169	Locate waste drum	NA	Document drum incident*	NA	Details of incident documented in Section 2.0

\* Per modifications outlined in letter from G.W. Baughman, CDH, to F. Lockhart, DOE, dated February 10, 1992.

NA = Not applicable    TBD = To be determined

\* This activity was performed during the preparation of this Work Plan.

TABLE 6.2 (Sheet 8 of 8)  
OU13 IAG REQUIREMENTS\*/FSP COMPARISON

IHSS Number	IAG*		FSP		Rationale
	Activity	No. of Samples/Borings	Activity	No. of Samples/Borings	
186	Submit documentation of cleanup operations	NA	Submit documentation of cleanup operations*	NA	In Agreement - information provided in Section 2.0
			Visual Inspection	NA	Identify visible contamination
			HPGe Radiological Survey	20' grid spacing	Increased Coverage
			Soil Gas Survey	20' grid spacing	Investigate VOC contamination of soils in area
			Surficial Soil Sampling	5	Confirm HPGe results
			Vertical Soil Profiles	TBD	Aid interpretation of HPGe survey
			Sample Existing Wells/Piezometers	2	Provide cost-effective information regarding groundwater conditions
	Soil Borings	TBD	Boreholes in Soil Gas and Radiation Anomalies - Boreholes along PWL	TBD - 4 boreholes along PWL	In Agreement
			Nested Tensiometers	TBD	Increased Coverage
			Monitoring Wells	TBD	Increased Coverage
190	Submit documentation regarding nature of leaks	TBD	Submit documentation regarding nature of leaks*	NA	In Agreement
191	Submit documentation regarding nature of spill	TBD	Submit documentation regarding nature of spill*	NA	In Agreement

\* Per modifications outlined in letter from G.W. Baughman, CDH, to F. Lockhart, DOE, dated February 10, 1992.

NA = Not applicable      TBD = To be determined

\* This activity was performed during the preparation of this Work Plan.

TABLE 6.3 (Sheet 1 of 5)  
SUMMARY OF SAMPLING PROCEDURES USED IN OU13 STAGE 1 RFI/RI

IHSS	Sample Type	Applicable Standard Operating Procedures (SOPS) <sup>1</sup>
117.1	Radiological survey	HPGe SOP under development, FO.11, FO.14, FO.16, GT.17
	Soil gas survey	FO.01, FO.03, FO.07, FO.11, FO.14, FO.18, FO.19, GT.09, GT.17, GT.19
	Surficial soil	GT.08, FO.03, FO.07, FO.10, FO.11, FO.13, FO.14, GT.17, as in OU1 Technical Memorandum 5
	Vertical soil profile	Vertical profile SOP under development, FO.03, FO.07, FO.10, FO.11, FO.13, FO.14, GT.17
	Groundwater	FO.01, FO.03, FO.05, FO.07, FO.11, FO.12, FO.13, FO.14, FO.15, FO.18, FO.19, GW.01, GW.05, GW.06
117.2	Radiological survey	HPGe SOP under development, FO.11, FO.14, FO.16, GT.17
	Soil gas survey	FO.01, FO.03, FO.07, FO.11, FO.14, FO.18, FO.19, GT.09, GT.17, GT.19
	Surficial soil	GT.08, FO.03, FO.07, FO.10, FO.11, FO.13, FO.14, GT.17, as in OU1 Technical Memorandum 5
	Vertical soil profile	Vertical profile SOP under development, FO.03, FO.07, FO.10, FO.11, FO.13, FO.14, GT.17
	Asphalt	Asphalt/concrete sampling SOP to be developed, FO.03, FO.07, FO.10, FO.11, FO.13, FO.14, GT.17
	Groundwater	FO.01, FO.03, FO.05, FO.07, FO.11, FO.12, FO.13, FO.14, FO.15, FO.18, FO.19, GW.01, GW.05, GW.06
117.3	Radiological survey	HPGe SOP under development, FO.11, FO.14, FO.16, GT.17
	Soil gas survey	FO.01, FO.03, FO.07, FO.11, FO.14, FO.18, FO.19, GT.09, GT.17, GT.19
	Surficial soil	GT.08, FO.03, FO.07, FO.10, FO.11, FO.13, FO.14, GT.17, as in OU1 Technical Memorandum 5
	Vertical soil profile	Vertical profile SOP under development, FO.03, FO.07, FO.10, FO.11, FO.13, FO.14, GT.17
	Groundwater	FO.01, FO.03, FO.05, FO.07, FO.11, FO.12, FO.13, FO.14, FO.15, FO.18, FO.19, GW.01, GW.05, GW.06

TABLE 6.3 (Sheet 2 of 5)  
SUMMARY OF SAMPLING PROCEDURES USED IN OU13 STAGE 1 RFI/RI

IHSS	Sample Type	Applicable Standard Operating Procedures (SOPS) <sup>1</sup>
128	Radiological survey	HPGe SOP under development, FO.11, FO.14, FO.16, GT.17
	Soil gas survey	FO.01, FO.03, FO.07, FO.11, FO.14, FO.18, FO.19, GT.09, GT.17, GT.19
	Surficial soil	GT.08, FO.03, FO.07, FO.10, FO.11, FO.13, FO.14, GT.17, as in OU1 Technical Memorandum 5
	Vertical soil profile	Vertical profile SOP under development, FO.03, FO.07, FO.10, FO.11, FO.13, FO.14, GT.17
	Groundwater	FO.01, FO.03, FO.05, FO.07, FO.11, FO.12, FO.13, FO.14, FO.15, FO.18, FO.19, GW.01, GW.05, GW.06
134	Radiological survey	HPGe SOP under development, FO.11, FO.14, FO.16, GT.17
	Soil gas survey	FO.01, FO.03, FO.07, FO.11, FO.14, FO.18, FO.19, GT.09, GT.17, GT.19
	Surficial soil	GT.08, FO.03, FO.07, FO.10, FO.11, FO.13, FO.14, GT.17, as in OU1 Technical Memorandum 5
	Vertical soil profile	Vertical profile SOP under development, FO.03, FO.07, FO.10, FO.11, FO.13, FO.14, GT.17
	Asphalt	Asphalt/concrete sampling SOP to be developed, FO.03, FO.07, FO.10, FO.11, FO.13, FO.14, GT.17
	Groundwater	FO.01, FO.03, FO.05, FO.07, FO.11, FO.12, FO.13, FO.14, FO.15, FO.18, FO.19, GW.01, GW.05, GW.06
148	Radiological survey	HPGe SOP under development, FO.11, FO.14, FO.16, GT.17
	Soil gas survey	FO.01, FO.03, FO.07, FO.11, FO.14, FO.18, FO.19, GT.09, GT.17, GT.19
	Surficial soil	GT.08, FO.03, FO.07, FO.10, FO.11, FO.13, FO.14, GT.17, as in OU1 Technical Memorandum 5
	Vertical soil profile	Vertical profile SOP under development, FO.03, FO.07, FO.10, FO.11, FO.13, FO.14, GT.17
	Asphalt	Asphalt/concrete sampling SOP to be developed, FO.03, FO.07, FO.10, FO.11, FO.13, FO.14, GT.17
	Soil boring	FO.01, FO.03, FO.04, FO.08, FO.09, FO.10, FO.11, FO.12, FO.13, FO.14, FO.16, FO.18, FO.19, GT.01, GT.02, GT.03, GT.05, GT.08, GT.17
	Groundwater	FO.01, FO.03, FO.05, FO.07, FO.11, FO.12, FO.13, FO.14, FO.15, FO.18, FO.19, GW.01, GW.05, GW.06



TABLE 6.3 (Sheet 3 of 5)  
SUMMARY OF SAMPLING PROCEDURES USED IN OU13 STAGE 1 RFI/RI

IHSS	Sample Type	Applicable Standard Operating Procedures (SOPS) <sup>1</sup>
152	Soil gas survey	FO.01, FO.03, FO.07, FO.11, FO.14, FO.18, FO.19, GT.09, GT.17, GT.19
	Groundwater	FO.01, FO.03, FO.05, FO.07, FO.11, FO.12, FO.13, FO.14, FO.15, FO.18, FO.19, GW.01, GW.05, GW.06
157.1	Radiological survey	HPGe SOP under development, FO.11, FO.14, FO.16, GT.17
	Soil gas survey	FO.01, FO.03, FO.07, FO.11, FO.14, FO.18, FO.19, GT.09, GT.17, GT.19
	Surficial soil	GT.08, FO.03, FO.07, FO.10, FO.11, FO.13, FO.14, GT.17, as in OU1 Technical Memorandum 5
	Vertical soil profile	Vertical profile SOP under development, FO.03, FO.07, FO.10, FO.11, FO.13, FO.14, GT.17
	Groundwater	FO.01, FO.03, FO.05, FO.07, FO.11, FO.12, FO.13, FO.14, FO.15, FO.18, FO.19, GW.01, GW.05, GW.06
158	Radiological survey	HPGe SOP under development, FO.11, FO.14, FO.16, GT.17
	Soil gas survey	FO.01, FO.03, FO.07, FO.11, FO.14, FO.18, FO.19, GT.09, GT.17, GT.19
	Surficial soil	GT.08, FO.03, FO.07, FO.10, FO.11, FO.13, FO.14, GT.17, as in OU1 Technical Memorandum 5
	Vertical soil profile	Vertical profile SOP under development, FO.03, FO.07, FO.10, FO.11, FO.13, FO.14, GT.17
	Groundwater	FO.01, FO.03, FO.05, FO.07, FO.11, FO.12, FO.13, FO.14, FO.15, FO.18, FO.19, GW.01, GW.05, GW.06
171	Radiological survey	HPGe SOP under development, FO.11, FO.14, FO.16, GT.17
	Soil gas survey	FO.01, FO.03, FO.07, FO.11, FO.14, FO.18, FO.19, GT.09, GT.17, GT.19
	Surficial soil	GT.08, FO.03, FO.07, FO.10, FO.11, FO.13, FO.14, GT.17, as in OU1 Technical Memorandum 5
	Vertical soil profile	Vertical profile SOP under development, FO.03, FO.07, FO.10, FO.11, FO.13, FO.14, GT.17
	Groundwater	FO.01, FO.03, FO.05, FO.07, FO.11, FO.12, FO.13, FO.14, FO.15, FO.18, FO.19, GW.01, GW.05, GW.06
	Sump Water	SW.1, SW.2, SW.3, FO.03, FO.06, FO.07, FO.10, FO.13

TABLE 6.3 (Sheet 4 of 5)  
SUMMARY OF SAMPLING PROCEDURES USED IN OU13 STAGE 1 RFI/RI

IHSS	Sample Type	Applicable Standard Operating Procedures (SOPS) <sup>1</sup>
186	Radiological survey	HPGe SOP under development, FO.11, FO.14, FO.16, GT.17
	Soil gas survey	FO.01, FO.03, FO.07, FO.11, FO.14, FO.18, FO.19, GT.09, GT.17, GT.19
	Surficial soil	GT.08, FO.03, FO.07, FO.10, FO.11, FO.13, FO.14, GT.17, as in OU1 Technical Memorandum 5
	Vertical soil profile	Vertical profile SOP under development, FO.03, FO.07, FO.10, FO.11, FO.13, FO.14, GT.17
	Soil boring	FO.01, FO.03, FO.04, FO.08, FO.09, FO.10, FO.11, FO.12, FO.13, FO.14, FO.16, FO.18, FO.19, GT.01, GT.02, GT.03, GT.05, GT.08, GT.17
	Groundwater	FO.01, FO.03, FO.05, FO.07, FO.11, FO.12, FO.13, FO.14, FO.15, FO.18, FO.19, GW.01, GW.05, GW.06

TABLE 6.3 (Sheet 5 of 5)  
SUMMARY OF SAMPLING PROCEDURES USED IN OU13 STAGE 1 RFI/RI

Standard Operating Procedures (SOPs) -

FO.01, Air Monitoring and Dust Control  
FO.03, General Equipment Decontamination  
FO.04, Heavy Equipment Decontamination  
FO.05, Handling of Purge and Development Water  
FO.07, Handling of Decontamination Water and Wash Water  
FO.08, Handling of Drilling Fluids and Cuttings  
FO.09, Handling of Residual Samples  
FO.10, Receiving, Labeling, and Handling Environmental  
Materials Containers  
FO.11, Field Communications  
FO.12, Decontamination Facility Operations  
FO.13, Containerization, Preserving, Handling and Shipping of  
Soil and Water Samples  
FO.14, Field Data Management  
FO.15, Photoionization Detectors (PIDs) and  
Flame Ionization Detectors (FIDs)  
FO.16, Field Radiological Measurements  
FO.18, Environmental Sample Radioactivity Content Screening  
FO.19, Base Laboratory Work  
GT.01, Logging Alluvial and Bedrock Material  
GT.02, Drilling and Sampling Using Hollow Stem  
Auger Techniques  
GT.03, Isolating Bedrock from Alluvium with Grouted  
Surface Casing  
GT.04, Rotary Drilling and Rock Coring  
GT.05, Plugging and Abandonment of Boreholes  
GT.06, Monitoring Wells and Piezometer Installation  
GT.08, Surface Soil Sampling  
GT.09, Soil Gas Sampling and Field Analysis  
GT.10, Borehole Clearing  
GT.11, Plugging and Abandonment of Wells  
GT.17, Land Surveying  
GT.19, Field Gas Chromatographs  
GW.01, Water Level Measurements in Wells and Piezometers  
GW.02, Well Development  
GW.05, Field Measurement of Groundwater Field Parameters  
GW.06, Groundwater Sampling  
SW.1, Surface Water Collection Activities  
SW.2, Field Measurement of Surface Water Parameters  
SW.3, Surface Water Sampling

References -

EG&G, 1991, Rocky Flats Plant EMD Operating Procedures Manual, Volume II: Groundwater,  
Manual No. 5-21200-OPS-GW.  
EG&G, 1992, Rocky Flats Plant EMD Operating Procedures Manual, Volume I: Field Operations,  
Manual No. 5-21200-OPS-FO.  
EG&G, 1992, Rocky Flats Plant EMD Operating Procedures Manual, Volume III: Geotechnical,  
Manual No. 5-21200-OPS-GT.  
EG&G, 1992, Rocky Flats Plant EMD Operating Procedures Manual, Volume IV: Surface Water,  
Manual No. 5-21200-OPS-SW.

planning more detailed investigations of each IHSS. The types of activities to be conducted during Stage 1 include:

- Visual inspections;
- Surface radiological surveys;
- Soil-gas surveys;
- Limited numbers of soil borings;
- Surficial soil and vertical profile sampling; and
- Groundwater sampling from existing wells and piezometers.

The rationale for sampling groundwater from the existing wells and piezometers in the vicinity of OU13 is based on the fact that the current quality of the groundwater beneath the operable unit is not known. Groundwater quality data is available for only one well located within OU13. Sampling of the existing wells and piezometers provides a cost-effective means for better assessing groundwater conditions within the operable unit. The data obtained from this activity will also enable a more complete evaluation of the analytical data that currently exists for these wells and piezometers in and around OU13.

Upon completion of Stage 1, the data collected during Stage 1 screening activities will be evaluated so that subsequent stages of the investigation can be adequately planned. These data along with recommendations for Stage 2 investigations will be summarized in a technical memorandum. Due to the turn-around times involved with obtaining laboratory results, this technical memorandum is not anticipated to provide the results of the laboratory analysis of borehole, surficial soil, and groundwater samples.

Stage 2 sampling will be used to confirm the results of the Stage 1 surveys and to provide additional information on those sites where contamination was found to be present in Stage 1. At those sites where no contamination was indicated by Stage 1 activities, Stage 2 sampling will be performed to confirm the absence of contamination. Activities to be conducted under Stage 2 include:

- Surface scrape sampling at borehole locations;
- Borehole sampling; and
- Sampling of groundwater using the Hydropunch®, or equivalent, technology at borehole locations.

Upon completion of Stage 2, data collected during Stages 1 and 2 will be fully evaluated to determine if further investigation of each IHSS is required. The results of Stages 1 and 2 and the Stage 3 FSAP will be summarized in a technical memorandum.

Stage 3 will attempt to assess the migration of contamination from IHSSs determined to be sources of contamination in Stages 1 and 2. It is currently anticipated that groundwater monitoring wells will be required to assess contaminant migration. To the extent possible, existing wells and piezometers will be used. Based on the proximity of several IHSSs to one another, it is also anticipated that some wells may be used to assess contamination attributable to more than one IHSS.

More extensive methods of sampling may be required on a case by case basis. It may be possible to employ the Hydropunch®, or equivalent, technology to outline the extent of the contaminant plumes in the subsurface. It may also be necessary to evaluate possible hydraulic connection between the Rocky Flats Alluvium and the Arapahoe Formation if the borings installed during Stage 2 indicate that the No. 1 sandstone subcrops beneath the alluvium near a

particular IHSS(s). If the results of Stages 1 and 2 indicate the need for sampling other environmental media, such as surface water and sediments, these investigations will be implemented during Stage 3. The need for such investigations will be established in the technical memorandum submitted at the completion of Stage 2.

The applicability of vadose zone monitoring and sampling techniques in the OU13 area will also be investigated. The results of vadose zone investigations for Operable Unit 12 and the Sewage Treatment Plant (STP) will be reviewed for applicability to OU13. The spatial relationship of potential contamination sources to unpaved areas which can serve as conduits for infiltration and groundwater recharge will be identified in the technical memorandum prepared at the completion of Stage 2. The following methods will also be evaluated for use in that technical memorandum.

One method to measure soil moisture profiles at unpaved IHSSs is through the use of vertically-nested tensiometers or equivalent instruments. Tensiometers can be inserted by drilling small diameter boreholes either with hand augers or with a vehicle mounted hydraulic probe. Subsurface geologic conditions may limit the success of these installation methods. Transducers connected to the tensiometers produce *in situ* readings of soil-water pressure which are recorded electronically in digital form. Soil-water pressure measurements are then used to determine response of vadose zone moisture to precipitation events, and to evaluate whether soil wetting fronts reach the water table. In areas where infiltration is found to reach the water table, a potential method to be used in evaluating the mobility of contaminants present in the vadose zone is leaching tests. Leachability data are used to substantiate whether individual IHSSs are current contributors to observed groundwater contamination. SOPs do not currently exist for vadose zone monitoring and leachability testing and will be developed.

### 6.2.3 Analytical Rationale

The potential contaminants present for each IHSS in OU13 are listed in Table 5.3. These contaminants were identified through a review of the information provided in Section 2.0 and together with the analytes specified by the IAG provide the basis for the analytical parameters for this investigation. However, the operational histories and release histories are not clearly defined for many of the IHSSs, and the available analytical data indicate the presence of contaminants in or near some IHSSs not known to have been released in these IHSSs. Therefore, it is necessary to utilize a more comprehensive list of analytes. The specific analytes that will be used for each stage of the Phase I RFI/RI are presented in Table 6.4 (also see Table 5.3).

Analytical results from the sampling may dictate future analytical parameters. Utilization of the parameters listed in Table 6.4 may be modified as appropriate based on additional data compilation to provide maximum potential for identifying all possible contaminants present in OU13. Analytes for later stages will be selected based on concentration levels exceeding values identified by the Background Geochemical Characterization Report and updates to that report. Decisions regarding analytical parameter selection will be documented by submitting technical memoranda.

### 6.2.4 Relevant Studies of Other OUs

Current and planned investigations at other OUs may provide data relevant to the Phase I investigation of OU13. Although areas of overlap with other OUs do not imply a reduction in scope of the Phase I investigation of OU13, such overlaps will be examined to prevent duplication of effort. Provided that the specified objectives of the OU13 Phase I RFI/RI are achieved, data from studies of other OUs shall be utilized to supplement or replace activities in

**TABLE 6.4 (Sheet 1 of 2)**  
**PHASE I, STAGE 1, ANALYTICAL PROGRAM**

[illegible]



TABLE 6.4 (Sheet 2 of 2)  
PHASE I, STAGE 1, ANALYTICAL PROGRAM

PARAMETERS	IHSS										
	117.1	117.2	117.3	128 & 134(N)	134(S)	148	152	157.1	158	171	186
Sump Liquids Analyses TAL Metals										♦	
TCL Volatiles										♦	
TCL Semivolatiles										♦	
Radionuclides - Full Suite <sup>c</sup>										♦	
Field Parameters <sup>f</sup>										♦	

See Table 5.3 for a complete list of analytes, detection limits, and analytical methods.

- <sup>a</sup> Vertical profile samples will also be taken at selected locations for analysis with a laboratory HPGe.
- <sup>b</sup> All soil gas samples will be analyzed in the field for the constituents listed in Sections 6.3.1.1 to 6.3.1.11 for each IHSS.
- <sup>c</sup> Analysis of the following radionuclides at a radiochemistry laboratory - gross alpha, gross beta, americium-241, plutonium-239/240, tritium, uranium-233/234, uranium-235, and uranium-238.
- <sup>d</sup> Analysis of samples for gamma-emitting radionuclides with a laboratory HPGe.
- <sup>e</sup> Chloride, fluoride, nitrate, and sulfate.
- <sup>f</sup> pH, temperature, and specific conductance

OU13. These determinations will be made on a case-by-case basis. Decisions regarding use of data from studies of other OUs will be documented by submitting technical memoranda.

In addition, the Final Preassessment Site Investigation for the Building 374 Waste System Evaporator will provide data applicable to IHSSs 158 and 186. Surface soil samples are to be collected from IHSS 158 and surface and subsurface soils are to be collected from IHSS 186 as part of this investigation. When the results of this investigation become available, they will be evaluated and presented in the technical memorandum prepared prior to Stage 2 and/or Stage 3.

### 6.3 SAMPLING PROGRAM

This section describes the Phase I RFI/RI investigation activities at each IHSS including sample locations and frequencies. The sampling programs for each IHSS are shown in Figures 6-1A to 6-1D and are described in detail in the following sections. The sampling activities and analytical program for each IHSS are summarized in Tables 6.1 and 6.4, respectively. As described in Section 2.2, it is likely that there would be no detectable impacts to environmental media as a result of the releases known to have occurred in IHSSs 190 and 191. Section 2.2 also provides information which indicates that the burial of the drum of hydrogen peroxide in IHSS 169 probably did not occur and is the same incident as that described for IHSS 191. Regardless of the potential location of this incident, it is not likely that there would be detectable impacts attributable to it. Therefore, no further investigation of IHSSs 169, 190, and 191 is proposed. That portion of IHSS 190 which includes the Central Avenue Ditch will be investigated as part of the integrated field sampling plan under development by EG&G.

### 6.3.1 Stage 1 Investigation

Stage 1 sampling efforts include a visual inspection, surface radiological and soil gas surveys, limited numbers of soil borings, surficial soil sampling, vertical profile sampling, and sampling of existing groundwater monitoring wells and piezometers. Sections 6.3.1.1 to 6.3.1.14 define the details of the Stage 1 sampling program for each IHSS. In general, with the exception of sampling existing wells and piezometers, Stage 1 activities will be conducted in the order of surface radiological surveys, collection of surficial soil and vertical profile samples, soil gas surveys, and drilling of boreholes. Figure 6-2 illustrates the locations of the existing wells and piezometers to be sampled during Stage 1 and provides an indication to which IHSSs the groundwater data collected will be applicable. These wells and piezometers will be sampled once for the analytes specified in Table 6.4.

Surface radiological survey techniques will include high purity germanium (HPGe) radiological surveys supplemented with surface soil samples and vertical profile samples. The HPGe detector was selected for these surveys instead of the G-M or FIDLER instruments specified by Table 5 of the IAG because the HPGe will provide greater areal coverage and higher quality results. The HPGe gamma ray detector that will be used is capable of high resolution gamma ray spectroscopy enabling the identification and quantification of gamma-emitting radionuclides. The detector is mounted on either a tripod or a vehicle and placed a set distance above the ground surface to measure gamma rays which originate from surface media. Tripod-mounted HPGe instruments are currently available and in use at RFP, and this FSAP assumes that radiological surveys will be performed with these instruments. If a vehicle-mounted system becomes available for use at OU13, the grid spacings described below for radiological surveys will need to be adjusted for surveys of certain portions of IHSSs. As outlined below, the detector may also be placed directly over a hole cut in the pavement in paved areas of an IHSS. The detector

system integrates gamma activity over the detector's "field of view," a volume defined by which 90 percent of those gammas originating in the surface media are measured. It is assumed that radionuclide distribution is relatively homogenous over the field of view, and that the distribution varies only with depth. HPGe results are typically reported as concentration per unit mass, picoCuries per gram (pCi/g).

Screening level activities for chemical contamination will consist of soil gas surveys and surficial soil sampling. A vehicle equipped with a hydraulic probing rig will be used for the collection of soil gas samples. In areas where access with a vehicle is not possible, the soil gas probes will be driven by hand. After an access hole has been cut through concrete or pavement, if present, the rig will be set up on each sampling point. To collect a soil gas sample, the sampling probe will then be driven to a depth of 5 ft, the retracting tip will be pulled back, and a vacuum applied to obtain the soil gas sample. The sample will be analyzed in a mobile laboratory for the analytes specified in the following sections for each IHSS and results will be obtained within minutes. The analytes specified for each IHSS include those required by the IAG and those indicated by the available analytical data presented in Section 2.0. The analytes selected based on the information presented in Section 2.0 are those VOCs detected in borehole or groundwater samples from the nearest downgradient well(s) to each IHSS.

Because the available historical data indicate the potential for contamination with metals at several OU13 IHSSs, surficial soil samples will be taken during Stage 1 at those IHSSs so as to determine the presence or absence of such contamination. Effective field screening methods for metals in soil samples are not currently available, thus requiring that the soil samples collected be sent to a laboratory for analysis. A limited number of these samples will also be analyzed for radionuclides in either an onsite laboratory with a shielded HPGe detector or a radiochemistry laboratory. At selected locations vertical profile samples taken at 0 to 2, 2 to 4, and 4 to 6-inch vertical depths will also be collected and measured with a laboratory HPGe. The surficial soil

and vertical profile samples analyzed for radionuclides will assist in confirming the results of the HPGe survey and provide information regarding radionuclide depth distributions. At sites where the potential exists for subsurface contamination with metals and radionuclides that would not be detected in surficial soil samples, drilling of soil borings will substitute for or supplement the collection of surficial soil samples. Analysis of samples in a radiochemistry laboratory will also determine the concentration of non-gamma-emitting radionuclides.

Surficial and subsurface soil samples that will be measured with a laboratory HPGe will be stored in containers for 30 days to allow radon gas to equilibrate with parent radionuclides present in the soil matrix. After 30 days, a shielded HPGe will be used to detect concentrations of gamma-emitting radionuclides in the samples.

The field sampling program described in the following sections for each IHSS provides for screening and surficial soil sampling to be initially completed on standard grids, with additional sampling points added to further define anomalous readings. The use of quick and relatively inexpensive screening methods allows the determination of general site conditions as well as the qualitative identification of contaminated areas at each IHSS. It is realized that the success of such methods is somewhat dependent on subsurface geology in the OU13 area.

The approach used to determine grid spacing and sample locations for the different screening and sampling activities within this work plan considered not only statistics (Section 5.1.2.4) and site history, but the capabilities of the technologies used. For example, the tripod-mounted HPGe radiological surveys proposed in this plan provide soil concentration results representing an approximate 23-ft diameter circular area, not just a single point. Therefore, grid spacing for radiological surveys is set at 20 ft, which provides for approximately 90 percent coverage of a site.

Where an IHSS or portion of an IHSS is paved, the technique for performing the HPGe surface will vary depending on the IHSS history. At those IHSSs where pavement was present at the time of the documented or potential releases, the paved area will be surveyed as described above to identify radionuclide concentrations of paved surface. After the results of the HPGe survey have been evaluated, a limited number of pavement samples will also be collected at areas of anomalous readings.

In areas where pavement was applied after the releases of interest, the conventional HPGe survey cannot be applied to the paved surface because the surfacing will essentially block most, if not all, of the gamma-ray emissions associated with a source beneath the pavement. Consequently, a 4 to 8 inch diameter access hole will be cut through the surfacing to enable the performance of HPGe surveys and other screening and sampling activities. In addition, any base material that was placed prior to paving will be removed to ensure that the measurements obtained are as representative as possible of the soils present at the time of the release. Using a technique suggested by EG&G Nuclear Instruments Division, Boulder, Colorado, the HPGe instrument can be set directly over the hole in the asphalt and direct readings taken at each station. The resulting data will subsequently identify the radionuclides that are present and their indicated concentrations for each station. A 20-ft grid spacing will also be used for HPGe surveys of soils beneath paved areas. As described in Section 5.1.2.4, this grid spacing results in an acceptable probability of not finding an elliptical contaminated area approximately 16 ft by 32 ft in size.

As discussed above, minimal numbers of surficial soil and depth profile samples will be collected to confirm the results of the HPGe survey. At the time surficial soil samples are collected for analysis of nonradioactive parameters, a subset of the samples collected will be split and submitted for analysis of radionuclides. At those IHSSs where surficial soil sampling programs for nonradioactive parameters are not planned, surficial soil samples will be collected for analysis of radionuclides at a subset of the HPGe stations. After the completion of the HPGe surveys,

the resultant data will be examined and discussed with CDH and EPA and the location of vertical profile samples will be determined.

The soil gas survey will be established on 20-ft or 40-ft triangular grids (see Section 5.1.2.4). The basis for the grid spacing selected for soil gas and surficial soil sampling programs for each IHSS is discussed in the following sections. Surficial soil samples will be collected on 120-ft triangular grids (see Section 5.1.2.4), with additional points added in suspect locations (i.e., areas where stained soils exist or where activities are associated with likely spills).

#### 6.3.1.1 North Chemical Storage Site (IHSS 117.1)

Stage 1 sampling efforts for IHSS 117.1 will consist of a visual inspection, surface radiological and soil gas surveys, surficial soil sampling, and sampling of existing groundwater monitoring wells and piezometers (Figure 6-3 and Table 6.3). The Stage 1 surface radiological and soil gas surveys for this IHSS will be performed on triangular grid spacings of 20 feet. The analytical data available for borehole samples from well P214689, located within this IHSS, indicate that soils in the area contain above background concentrations of several radionuclides necessitating the performance of the surface radiological survey. Because the size of possible releases within this IHSS are not known, the 20-foot grid spacing for soil gas surveys will provide a conservative approach to locating contamination. Due to access and security restrictions, these investigations will not be performed within that section of the IHSS which is believed to extend into the Protected Area. This portion of the IHSS will be addressed as part of the Decommissioning and Decontamination Program at RFP. The portion of this IHSS that is paved will require access holes to be cut through the pavement prior to initiating these investigations. The available information regarding releases at this IHSS indicates that these releases occurred prior to the area being paved. Thus, these investigations will focus on the potential contamination of soils beneath

the pavement. As discussed in Section 6.3.1.12, the HPGe and soil gas surveys for this IHSS will also provide information regarding releases associated with IHSS 186.

The surface radiological survey will be performed with a tripod-mounted HPGe instrument over unpaved areas and with the HPGe instrument placed directly over access holes in the pavement in paved areas. Subsequent to the HPGe survey, surficial soil samples will be collected from seven locations for analysis of TAL metals (Figure 6-3). At one of these sampling sites, a surficial soil sample will also be collected for analysis of radionuclides with a laboratory HPGe to confirm the results of the HPGe survey. This sample will be split and sent to a radiochemistry laboratory for analysis. Depending on the results of the HPGe survey, vertical profile samples may also be collected.

The soil gas survey will analyze for the following compounds and will note any other compounds which were detected but not calibrated for:

IAG Required

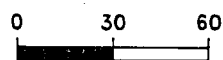
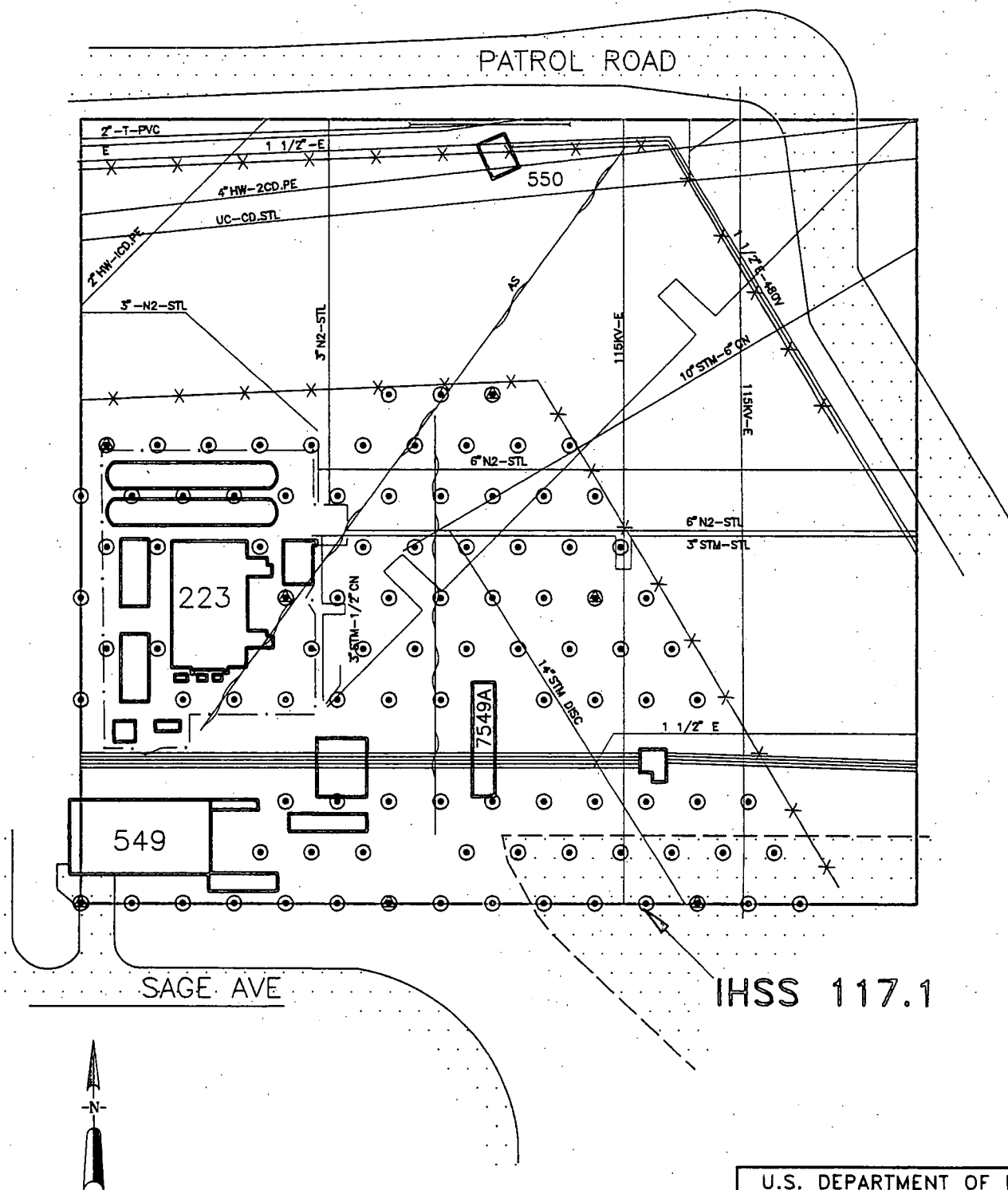
1,1,1-trichloroethane	perchloroethene	benzene	carbon tetrachloride
dichloromethane	trichloroethene		

Indicated by Available Data

total xylenes	carbon disulfide	acetone	ethylbenzene
toluene			

Analyses of groundwater samples from existing piezometers P214689 and P115589 will provide data which may be useful in assessing potential contamination associated with IHSS 117.1 (Figure 6-2). Groundwater samples from these piezometers will be analyzed for the constituents indicated in Table 6.4.





SCALE: 1" = 60'  
SCALE APPROXIMATE

- HPGe Station
- Soil Gas Survey Location
- △ Surficial Soil Sample

Note: Vertical profile samples may be taken at some HPGe stations contingent upon HPGe results.

Refer to Fig. 2-2, MASTER LEGEND, for explanation of symbols.

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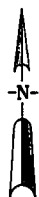
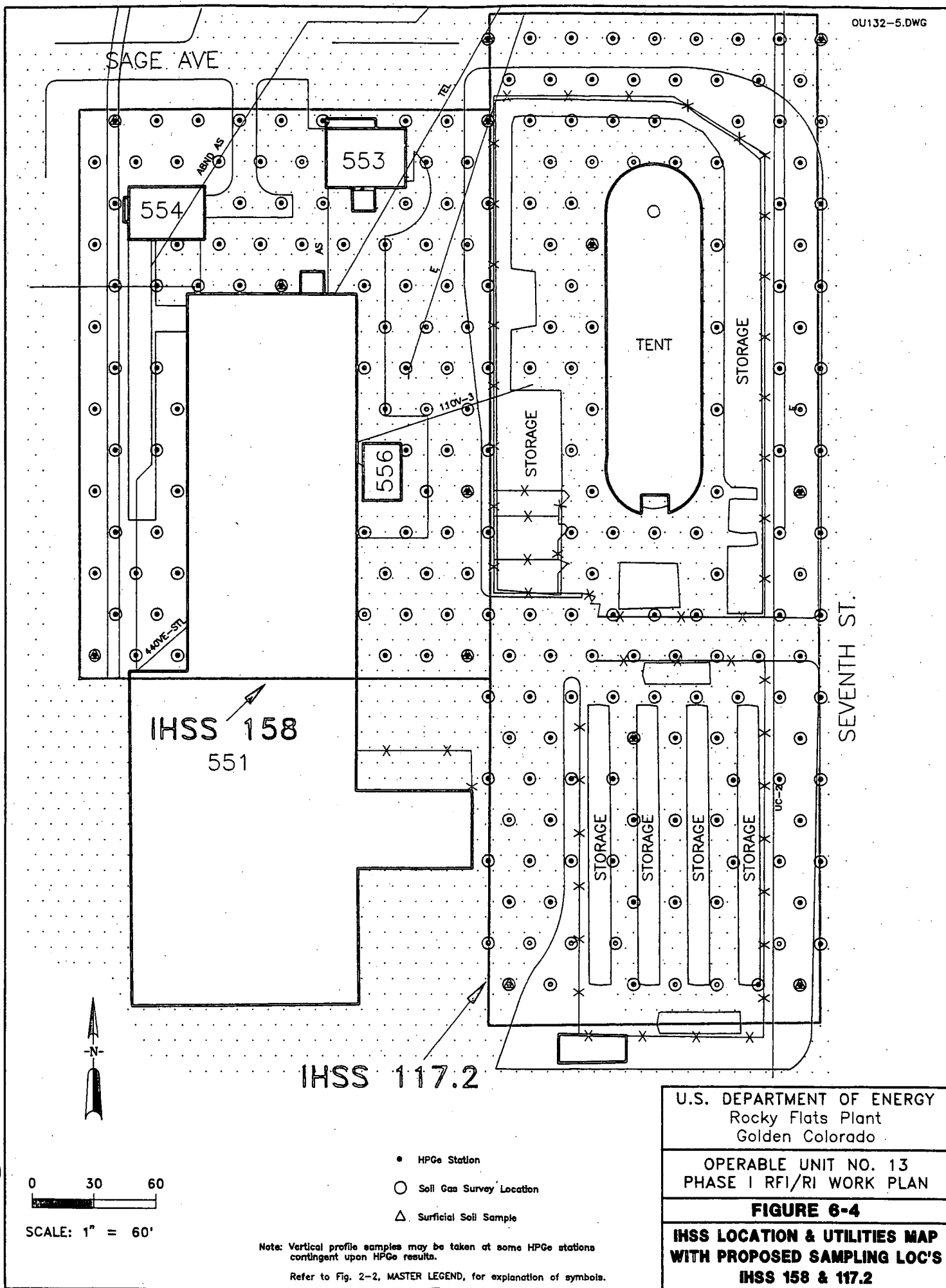
### FIGURE 6-3

**IHSS LOCATION & UTILITIES MAP  
WITH PROPOSED SAMPLING LOC'S  
IHSS 117.1**

### 6.3.1.2 Middle Chemical Storage Site (IHSS 117.2)

Stage 1 sampling efforts for IHSS 117.2 will consist of a visual inspection, surface radiological and soil gas surveys, surficial soil sampling, and sampling of existing groundwater monitoring wells and piezometers (Figure 6-4 and Table 6.3). The Stage 1 surface radiological and soil gas surveys for this IHSS will be performed on triangular grid spacings of 20 feet. Because the size of possible releases with this IHSS are not known, the 20-foot grid spacing for the soil gas survey will provide a conservative approach to locating contamination. The available information regarding releases at this IHSS indicates that these releases occurred both before and after the IHSS was paved. Thus, the investigation of this IHSS will focus on potential contamination of the asphalt as well as the soils beneath the asphalt. The entire area of IHSS 117.2 is paved, requiring access holes be cut through the pavement and base material removed prior to performing investigations of potential contamination in the soils beneath the pavement. The presence of a numerous items that are stored in this IHSS and of a large storage tent will not allow for the performance of these activities over the entire area of the IHSS (Figure 6-4). The sampling grid was adjusted to reflect these restrictions.

The surface radiological survey will initially be performed with the HPGe instrument mounted on a tripod to measure concentrations of radionuclides on the pavement surface. After the results of this survey have been evaluated, samples of asphalt will be collected at a maximum of 5 anomalous areas detected by this survey. These samples will be analyzed with a laboratory HPGe. Subsequently the area will be surveyed by placing the instrument directly over access holes in the pavement. Subsequent to this survey, surficial soil samples will be collected from seven locations for analysis of TAL metals (Figure 6-4). At one of these sampling sites, a surficial soil sample will also be collected for analysis of radionuclides with a laboratory HPGe to confirm the results of the HPGe survey. This sample will be split and sent to a radiochemistry



0 30 60  
SCALE: 1" = 60'

- HPG Station
- Soil Gas Survey Location
- △ Surficial Soil Sample

Note: Vertical profile samples may be taken at some HPG stations contingent upon HPGe results.  
Refer to Fig. 2-2, MASTER LEGEND, for explanation of symbols.

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**FIGURE 6-4**

**IHSS LOCATION & UTILITIES MAP  
WITH PROPOSED SAMPLING LOC'S  
IHSS 158 & 117.2**

laboratory for analysis. Depending on the results of the HPGe survey, vertical profile samples may also be collected.

The soil gas survey will analyze for the following compounds and will note any other compounds which were detected but not calibrated for:

IAG Required

1,1,1-trichloroethane	perchloroethene	benzene	carbon tetrachloride
dichloromethane	trichloroethene		

Indicated by Available Data

total xylenes	acetone	toluene	2-butanone
ethylbenzene			

Analyses of groundwater samples from existing piezometers P214689, P115589, P115689, and P215789 will provide data which may be useful in assessing potential contamination associated with IHSS 117.2 (Figure 6-2). Groundwater samples from these piezometers will be analyzed for the constituents indicated in Table 6.4.

6.3.1.3 South Chemical Storage Site (IHSS 117.3)

Stage 1 sampling efforts for IHSS 117.3 will consist of a visual inspection, surface radiological and soil gas surveys, surficial soil sampling, and sampling of existing groundwater monitoring wells and piezometers (Figure 6-5 and Table 6.3). The Stage 1 surface radiological and soil gas surveys for this IHSS will be performed on triangular grid spacings of 20 feet and 40 feet, respectively. The soil gas survey of this IHSS will be performed in conjunction with that of IHSS 152 (Section 6.3.1.7). These surveys will be conducted over the entire area of the IHSS

to the extent possible. The presence of Tank 224 and equipment associated with that tank will prevent the performance of these surveys over a portion of the IHSS within the berm for that tank.

The surface radiological survey will be performed with a tripod-mounted HPGe over the area of this IHSS that is outside the berm around Tank 224. Due to the fact that the area within the berm was disturbed considerably during the construction of Tank 224, it is not likely that surface contamination attributable to this IHSS would be detectable within the bermed area. Subsequent to the HPGe survey, surficial soil samples will be collected at five locations for analysis of TAL metals (Figure 6-5). At one of these sampling sites, a surficial soil sample will also be collected for analysis of radionuclides with a laboratory HPGe to confirm the results of the HPGe survey. This sample will be split and sent to a radiochemistry laboratory for analysis. Depending on the results of the HPGe survey, vertical profile samples may also be collected.

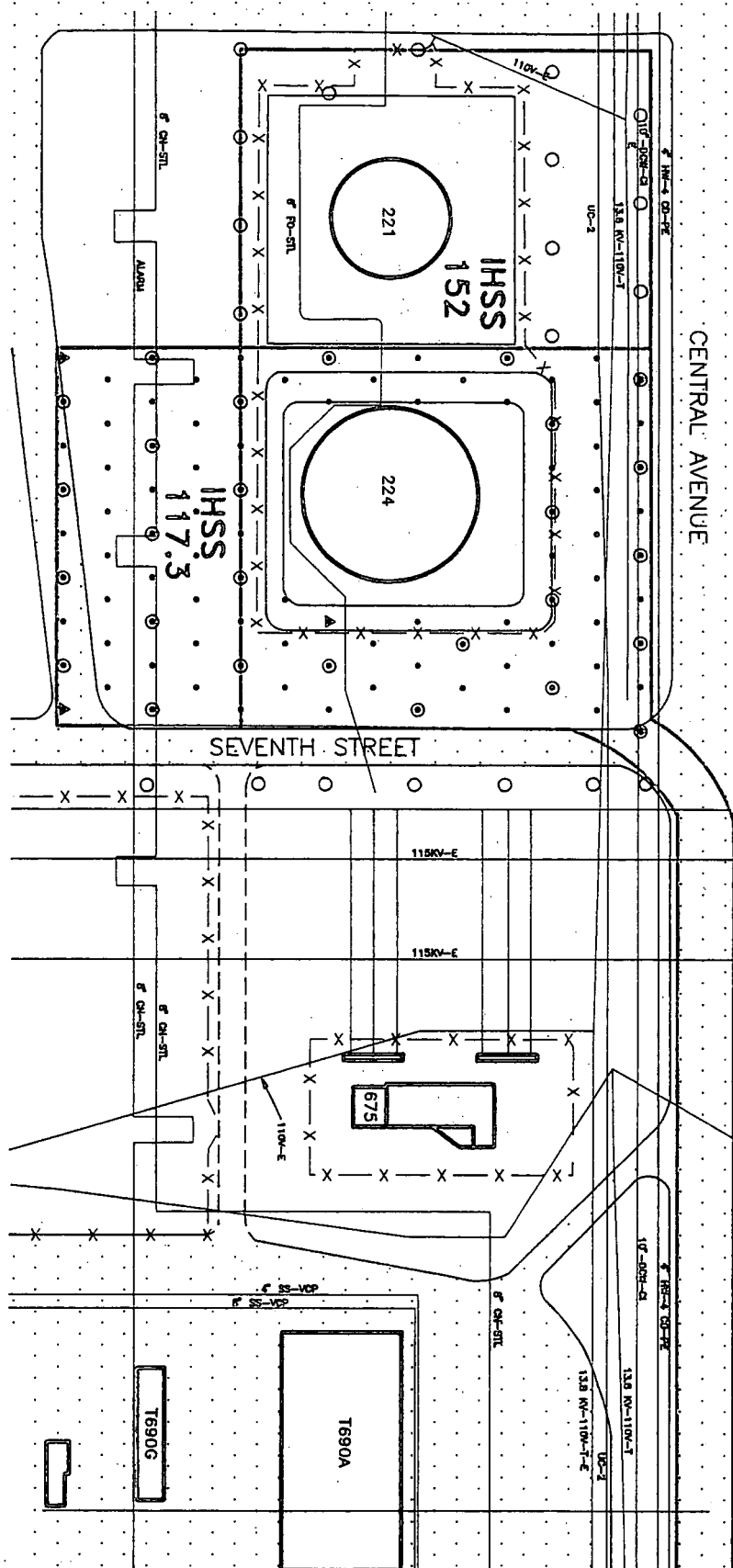
The soil gas survey of the area of IHSS 117.3 will analyze for the following compounds and will note any other compounds which were detected but not calibrated for:

IAG Required

1,1,1-trichloroethane	perchloroethene	benzene	carbon tetrachloride
dichloromethane	trichloroethene		

Because IHSS 152 also occurs in the same area as IHSS 117.3 and the soil gas surveys for both IHSSs will be performed together, the soil gas samples will also be analyzed for toluene and total xylenes.

Analyses of groundwater samples from existing well P418289 and piezometer P414189 will provide data which may be useful in assessing potential contamination associated with IHSS



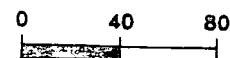
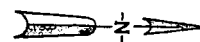
• HPGe Station

○ Soil Gas Survey Location

△ Surficial Soil Sample

Note: Vertical profile samples may be taken at some HPGe stations contingent upon HPGe results.

Refer to Fig. 2-2, MASTER LEGEND, for explanation of symbols.



SCALE: 1" = 80'

SCALE APPROXIMATE

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**FIGURE 6-5**

**IHSS LOCATION & UTILITIES MAP  
W/ PROPOSED SAMPLING LOC'S  
IHSS 117.3 & 152**

117.3 (Figure 6-2). Groundwater samples from these locations will be analyzed for the constituents indicated in Table 6.4.

#### 6.3.1.4 Oil Burn Pit No. 1 (IHSS 128)

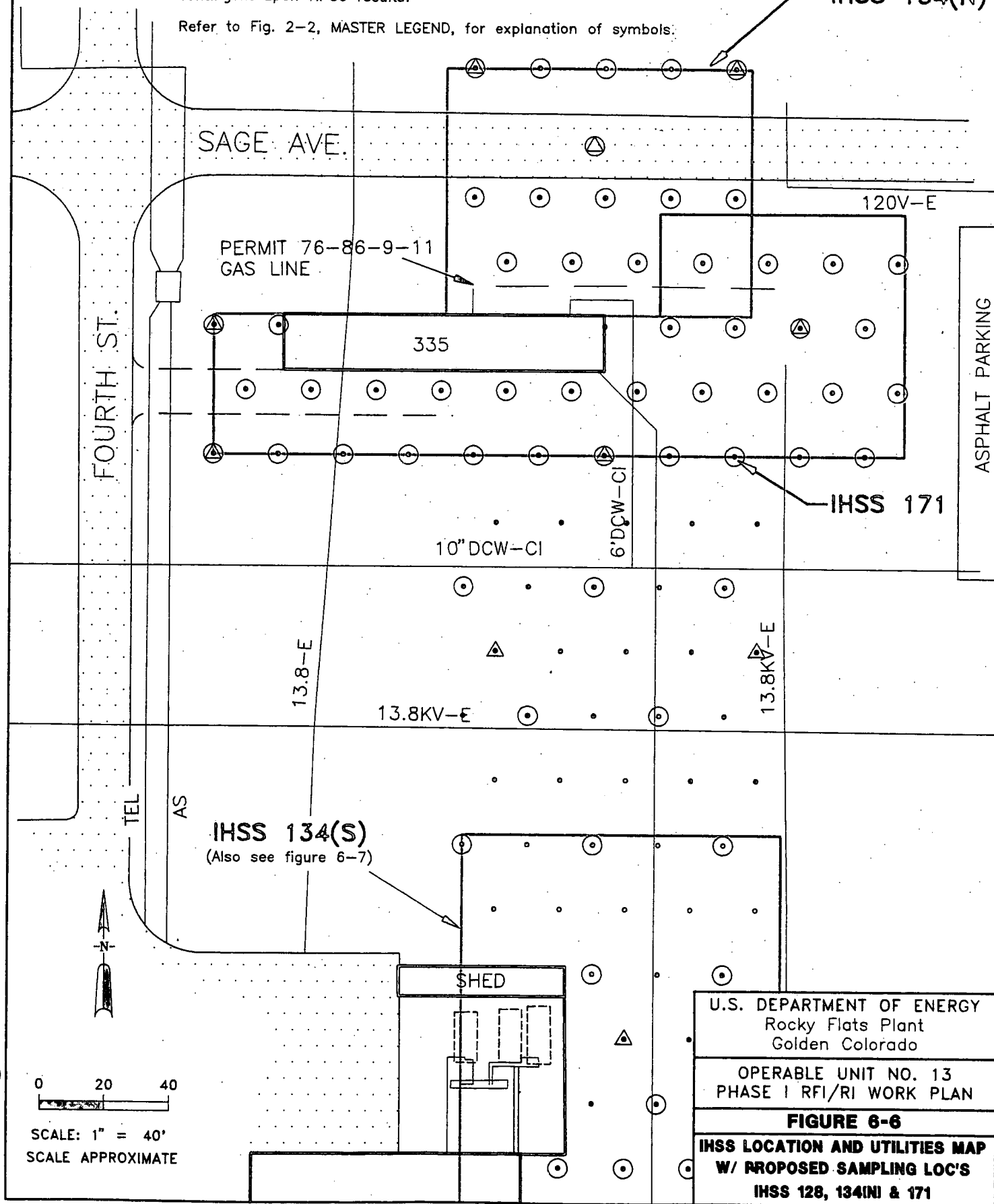
Stage 1 sampling efforts for IHSS 128 will consist of a visual inspection, surface radiological and soil gas surveys, surficial soil sampling, and sampling of existing groundwater monitoring wells and piezometers (Figure 6-6 and Table 6.3). These activities will also provide data required for the evaluation of the portion of IHSS 134 that occurs in this location (see Section 6.3.1.5). The Stage 1 surface radiological and soil gas surveys for this IHSS will be performed on triangular grid spacings of 20 feet. A 20-foot grid spacing was selected for the soil gas survey because the precise location of these IHSSs is not known and areas of contamination associated with them are likely to be relatively small. It is believed that these sites are located beneath the current location of Sage Avenue (Figure 6-6). It is anticipated that these surveys can be conducted between Sage Avenue and the drainage ditch to the south and the parking lot to the north. One sampling location will also be established on Sage Avenue near the center of these IHSSs. This sampling location will require that an access hole be cut through the pavement on Sage Avenue. It is estimated that approximately 10 feet of artificial fill was placed over these IHSSs during the construction of Sage Avenue. Therefore, a boring drilled to a depth of approximately 10 feet will be required for the placement of a soil gas probe beneath Sage Avenue.

The surface radiological survey will be performed with a tripod-mounted HPGe instrument over unpaved areas. Due to the depth of fill under Sage Avenue, no HPGe measurements will be taken in the paved portion of these IHSSs. A sample of the soil present at the base of the artificial fill will be collected from within the boring drilled for the soil gas survey for analysis of radionuclides with a laboratory HPGe. The concentration of lithium and magnesium will also be measured. Subsequent to the HPGe survey, surficial soil samples will be collected from two

- HPGe Station
- Soil Gas Survey Location
- △ Surficial Soil Sample

Note: Vertical profile samples may be taken at some HPGe stations contingent upon HPGe results.

Refer to Fig. 2-2, MASTER LEGEND, for explanation of symbols.





other locations for analysis of lithium and magnesium (Figure 6-6). At one of these sampling sites, a surficial soil sample will also be collected for analysis of radionuclides with a laboratory HPGe to confirm the results of the HPGe survey. This sample will be split and sent to a radiochemistry laboratory for analysis. Depending on the results of the HPGe survey, vertical profile samples may also be collected.

The soil gas survey will analyze for the following compounds and will note any other compounds which were detected but not calibrated for:

IAG Required

benzene                      toluene                      xylene

Indicated by Available Data

carbon disulfide              acetone

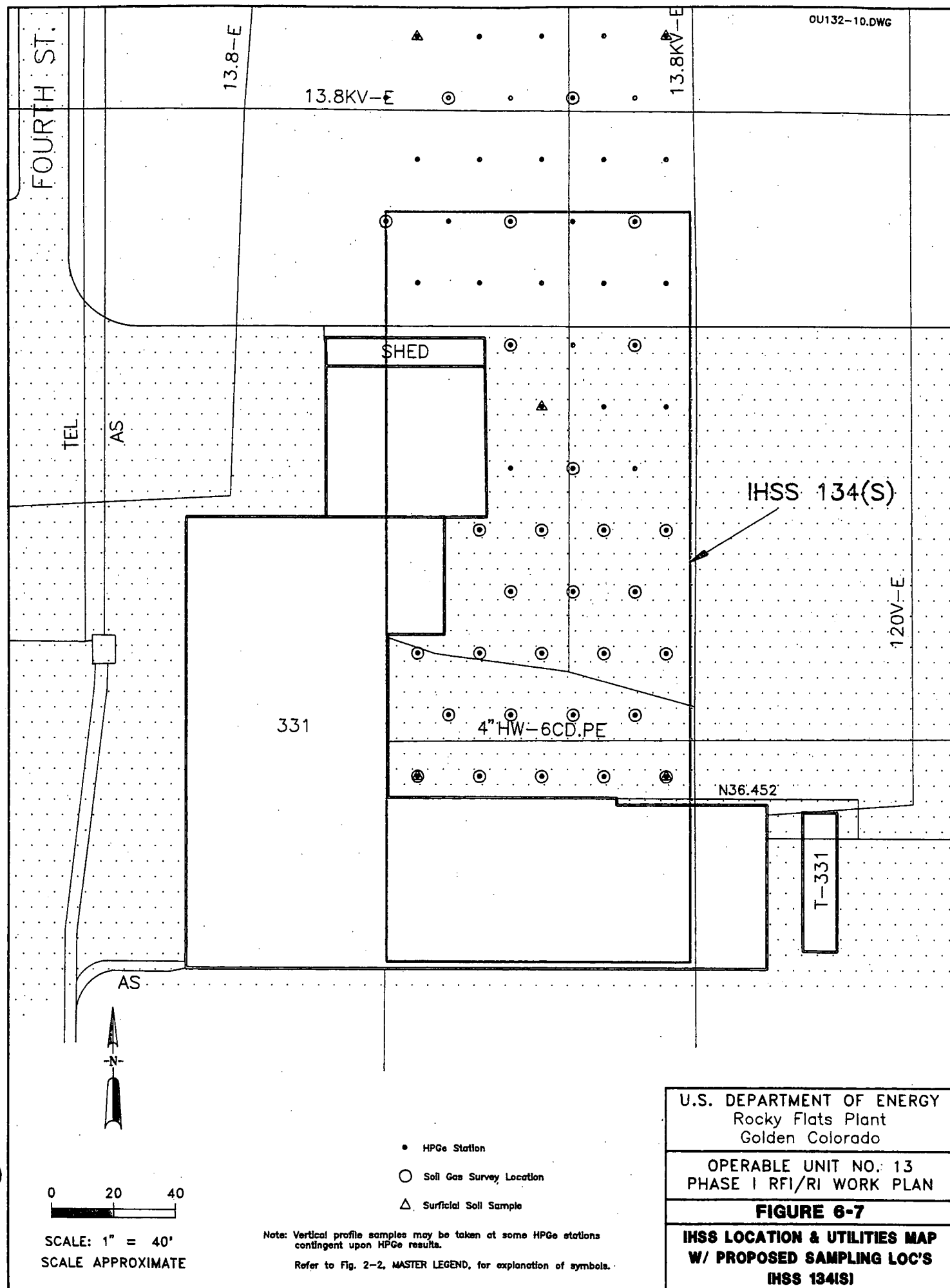
Analyses of groundwater samples from existing piezometers P114989, P114889, and P114789 will provide data which may be useful in assessing potential contamination associated with IHSS 128 and the northern portion of IHSS 134 (Figure 6-2). Groundwater samples from these piezometers will be analyzed for the constituents indicated in Table 6.4.

6.3.1.5              Lithium Metal Destruction Site (IHSS 134)

As discussed in Section 6.3.1.4, the northern portion of IHSS 134 will be investigated with IHSS 128. Stage 1 sampling efforts for the southern portion of IHSS 134 will consist of a visual inspection, surface radiological and soil gas surveys, surficial soil sampling, and sampling of existing groundwater monitoring wells and piezometers (Figure 6-7 and Table 6.3). The Stage 1 surface radiological survey for this IHSS will be performed on a triangular grid spacing of 20

feet. The available information regarding releases at this IHSS indicates that these releases occurred both before and after portions of the IHSS were paved. Thus, the investigation of this IHSS will focus on potential contamination of the asphalt as well as the soils beneath the asphalt. The surveys will be conducted, as possible, from the eastern addition of Building 331 north to IHSS 171 near Building 335 and from Building 331 east to the 334 parking area (Figures 6-6 and 6-7). The soil gas survey of this IHSS will be performed on a triangular grid spacing of 20 feet from Building 331 to approximately 100 ft north of Building 331 and then will use a 40-foot spacing northward to IHSS 171. The tighter grid spacing was selected for the area near Building 331 because most of the releases associated with this IHSS were believed to have occurred near Building 331. It is likely that the surveys of this IHSS will be performed in conjunction with the surveys of IHSS 171 (see Section 6.3.1.10). Those portions of this area that are paved will require that access holes be cut through the pavement and base material removed prior to initiating investigations of potential contamination of the soils beneath the pavement.

The surface radiological survey will be initially be performed with a tripod-mounted HPGe instrument over the entire area. After the results of this survey have been evaluated, samples of asphalt will be collected at a maximum of 4 anomalous areas detected by this survey. These samples will be analyzed with a laboratory HPGe. Subsequently the paved portion of the IHSS will be surveyed with the HPGe instrument placed directly over access holes in the pavement in paved areas. Subsequent to this survey, surficial soil samples will be collected from five locations for analysis of TAL metals and lithium (Figure 6-7). At one of these sampling sites, a surficial soil sample will also be collected for analysis of radionuclides with a laboratory HPGe to confirm the results of the HPGe survey. This sample will be split and sent to a radiochemistry laboratory for analysis. Depending on the results of the HPGe survey, vertical profile samples may also be collected.



The soil gas survey will analyze for the following compounds and will note any other compounds which were detected but not calibrated for:

IAG Required

benzene                      toluene                      xylene

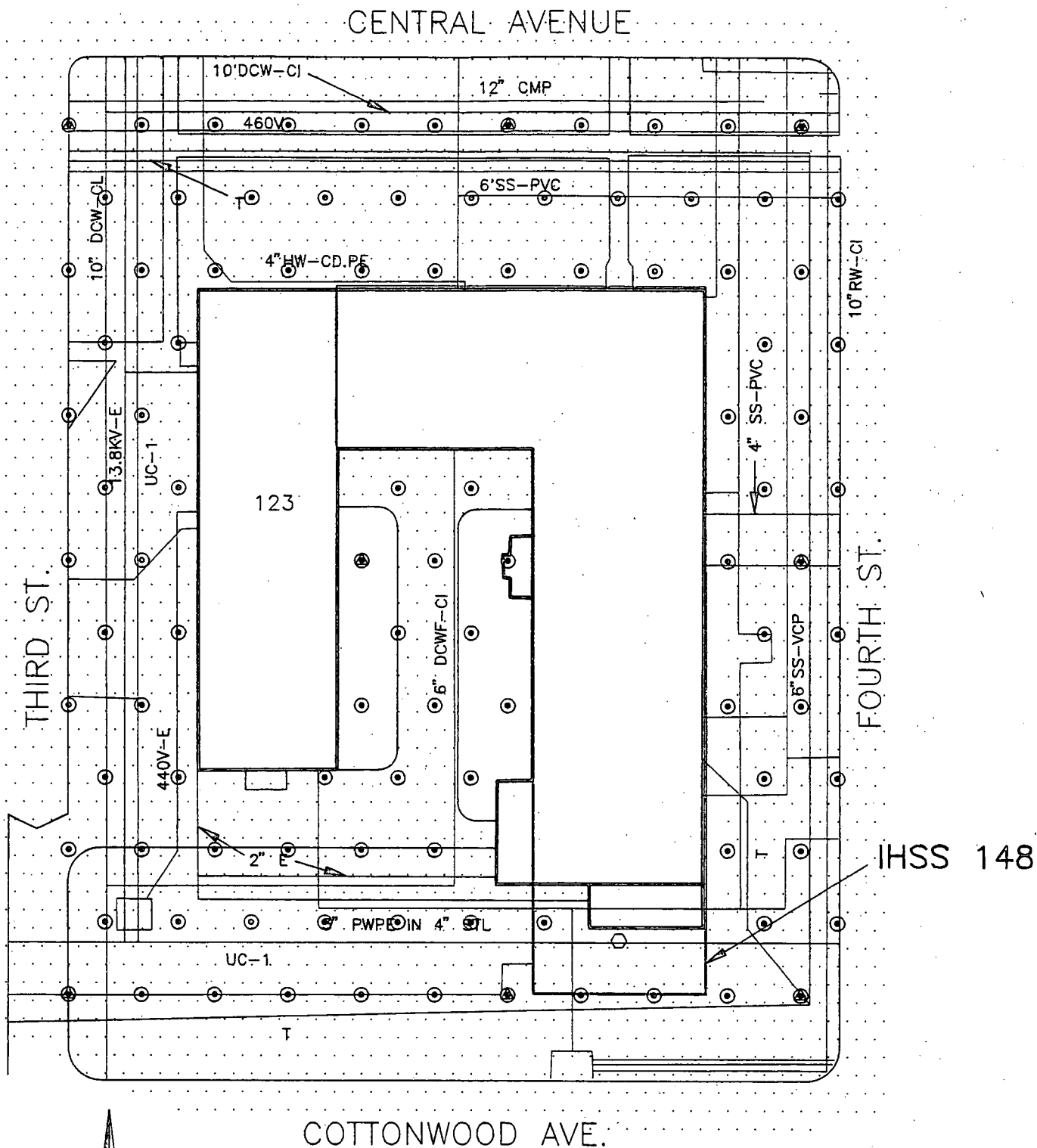
Indicated by Available Data

carbon disulfide              acetone

Analyses of groundwater samples from existing piezometer P115489 will provide data which may be useful in assessing potential contamination associated with IHSS 122 (Figure 6-2). Groundwater samples from this piezometer will be analyzed for the constituents indicated in Table 6.4.

6.3.1.6              Waste Spills (IHSS 148)

Stage 1 sampling efforts for IHSS 148 will consist of a visual inspection, surface radiological and soil gas surveys, one soil boring, and sampling of existing groundwater monitoring wells and piezometers (Figure 6-8 and Table 6.3). The Stage 1 surface radiological and soil gas surveys for this IHSS will be performed on initial grid spacings of 20 feet. It is believed that the releases that may have occurred within this IHSS occurred primarily beneath Building 123. The available information regarding releases at this IHSS also indicate that releases may have occurred around the building perimeter before and after the area south of the building was paved. Thus, the investigation in the paved areas surrounding the building will focus on potential contamination of the asphalt as well as the soils beneath the asphalt. The surface radiological and soil gas surveys will be performed around the perimeter of this building to the extent possible. The



0 20 40  
SCALE: 1" = 40'  
SCALE APPROXIMATE

- HPGe Station
- Soil Gas Survey Location
- △ Surficial Soil Sample
- Borehole Location

Note: Vertical profile samples may be taken at some HPGe stations contingent upon HPGe results.

Refer to Fig. 2-2, MASTER LEGEND, for explanation of symbols.

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**FIGURE 6-8**

**IHSS LOCATION & UTILITIES MAP  
WITH PROPOSED SAMPLING LOC'S  
IHSS 148**

surveys will be performed between Building 123 and Fourth Street to the east, Central Avenue to the north, and Third Street to the west. The southern side of Building 123 will be surveyed within an area extending from the building to approximately 20 feet south of the eastern wing of the building. This area includes the alcove between the wings of the building (Figure 6-8). Much of this area is paved and will require that access holes be cut through the pavement and base material removed prior to initiating the investigations of potential contamination in the soils beneath the pavement.

The surface radiological survey will initially be performed with a tripod-mounted HPGe instrument over the entire IHSS area. After the results of this survey have been evaluated, samples of asphalt will be collected at a maximum of four anomalous areas detected by this survey. These samples will be analyzed with a laboratory HPGe. Subsequently the paved portion of the IHSS will be surveyed with the HPGe instrument placed directly over access holes in the pavement. At eight locations surficial soil samples will also be collected for analysis of radionuclides with a laboratory HPGe to confirm the results of the HPGe survey (Figure 6-8). Two of these samples will be split and sent to a radiochemistry laboratory for analysis. Depending on the results of the HPGe survey, vertical profile samples may also be collected.

The IAG does not require the performance of a soil gas survey at IHSS 148. However, the available analytical data for well 4486, the nearest downgradient well to IHSS 148, indicate the presence of several VOCs in groundwater in the area. The source of these contaminants is not known, thus necessitating further investigation. The soil gas survey will analyze for the following compounds and will note any other compounds which were detected but not calibrated for:

1,1,1-trichloroethane	perchloroethene	trichloroethene	chloroform
1,1-dichloroethane	acetone		

One shallow soil boring will be drilled adjacent to the OPWL where it exits the south side of Building 123 (Figure 6-8). The invert elevation of the pipe at this point is approximately 2.5 feet below the ground surface. The boring will be drilled to approximately 3 feet in depth with a hand auger. A discrete sample will be taken at this depth and analyzed for TAL metals, radionuclides, nitrate, chloride, and sulfate (Table 6.4). Radionuclide analysis will be performed onsite with a laboratory HPGe.

Analyses of groundwater samples from existing well 4486 and piezometers P415989, P416189, P115589, and P115689 will provide data which may be useful in assessing potential contamination associated with IHSS 148 (Figure 6-2). Groundwater samples from these locations will be analyzed for the constituents indicated in Table 6.4.

#### 6.3.1.7 Fuel Oil Tank (IHSS 152)

Stage 1 sampling efforts for IHSS 152 will consist of a visual inspection, a soil gas survey and sampling of existing groundwater monitoring wells and piezometers (Figure 6-5 and Table 6.3). Because the releases known to have occurred within this IHSS are relatively large (i.e., hundreds of gallons), the Stage 1 soil gas survey for this IHSS will be performed on a triangular grid spacing of 40 feet (Figure 6-5). This survey will be conducted over the entire area of the IHSS to the extent possible. The presence of Tank 221 and equipment associated with the tank may prevent the performance of this survey over a portion of the IHSS within the berm for that tank (Figure 6-5). IHSS 117.3 is located within the eastern portion of this IHSS, and the soil gas surveys for both IHSSs will be performed at the same time. The survey will be performed over

an area bounded by Central Avenue on the north, Sixth Street on the west, Seventh Street to the east, and Cottonwood Avenue to the south. IHSS 117.2 is located downgradient of IHSS 152. The soil gas survey proposed for IHSS 117.2 will also analyze for the compounds of interest to IHSS 152 and will provide information regarding the possible presence of contamination attributable to IHSS 152. One line of soil gas probes will also be placed between Central Avenue and Building 551 and IHSS 117.2 to the north and between Seventh Street and the electrical transformers to the east. Any further extension of the soil gas survey immediately downgradient of IHSS 152 is not feasible due to the presence of buildings and utilities.

The soil gas survey will analyze for the following compounds and will note any other compounds which were detected but not calibrated for:

benzene                      toluene                      total xylenes

This list of compounds is based upon the requirements stated in the IAG. No historical data was obtained during the preparation of this work plan to indicate that a more extensive suite of parameters is required at this IHSS.

Analyses of groundwater samples from existing well P418289 and piezometer P414189 will provide data which may be useful in assessing potential contamination associated with IHSS 152 (Figure 6-2). Groundwater samples from these locations will be analyzed for the constituents indicated in Table 6.4.

#### 6.3.1.8              North Area Radioactive Site (IHSS 157.1)

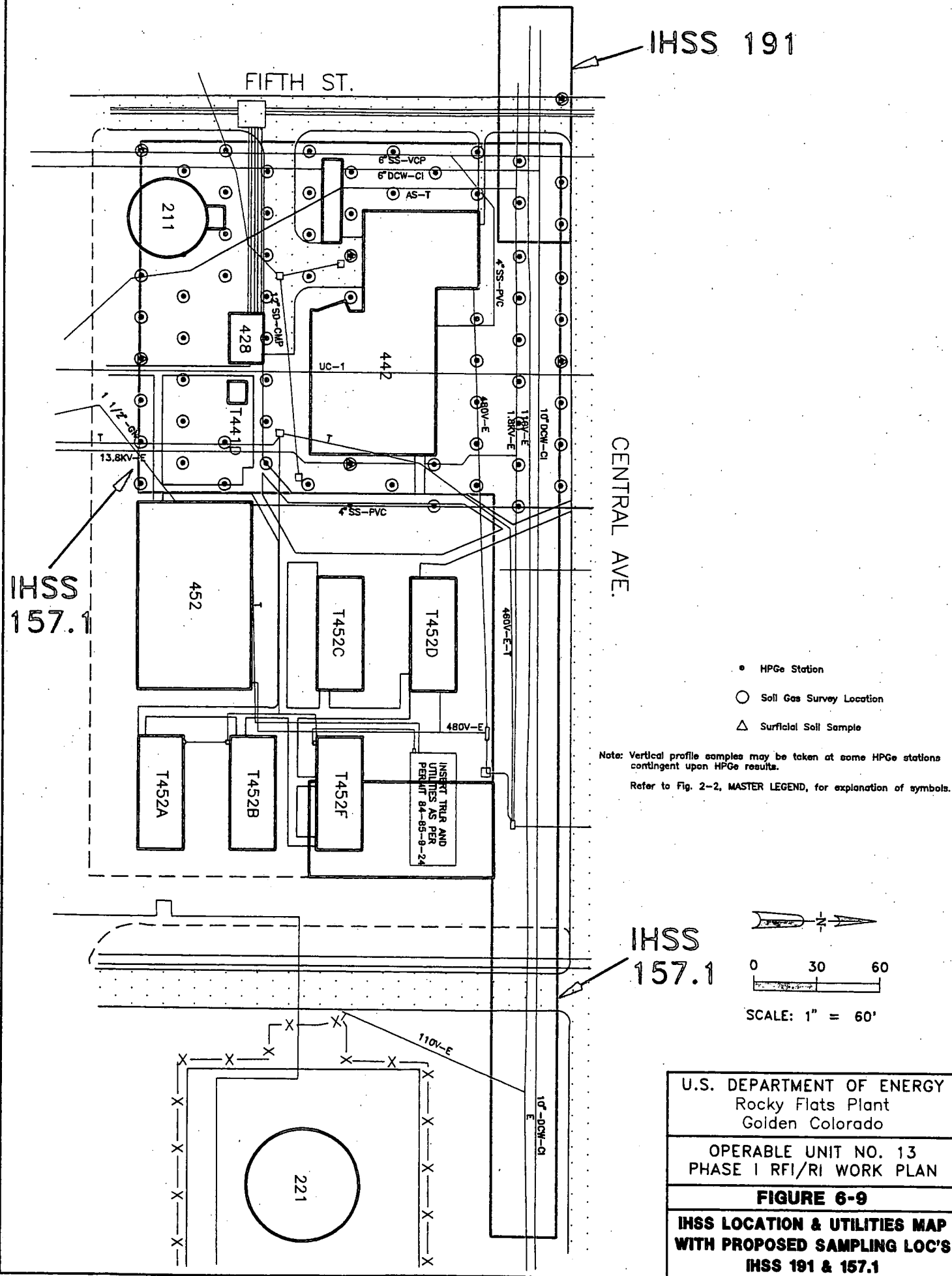
Stage 1 sampling efforts for IHSS 157.1 will consist of a visual inspection, surface radiological and soil gas surveys, surficial soil sampling, and sampling of existing groundwater monitoring



wells and piezometers (Figure 6-9 and Table 6.3). The Stage 1 surface radiological and soil gas surveys for this IHSS will be performed on triangular grid spacings of 20 feet. The 20-foot spacing for the soil gas surveys was selected because releases associated with this IHSS are believed to be relatively small. The available information regarding releases at this IHSS indicates that these releases occurred prior to the area south of Building 442 being paved. Thus, the investigation of this IHSS will focus on potential contamination of the soils beneath the pavement. The surface radiological and soil gas surveys will be performed around the perimeter of Building 442 to the extent possible. These surveys will be conducted in an area between the building and Central Avenue on the north, the sidewalk to the east, Fifth Street to the west, and extending approximately 40 feet to the south of the building in the area of 42 Drive (Figure 6-9). Much of this area is paved and will require that access holes be cut through the pavement and base material removed prior to initiating these surveys.

The surface radiological survey will be performed with a tripod-mounted HPGe instrument over unpaved areas and with the HPGe instrument placed directly over access holes in the pavement in paved areas. Subsequent to the HPGe survey, surficial soil samples will be collected from six locations for analysis of TAL metals (Figure 6-9). At one of these sampling sites, a surficial soil sample will also be collected for analysis of radionuclides with a laboratory HPGe to confirm the results of the HPGe survey. This sample will be split and sent to a radiochemistry laboratory for analysis. Depending on the results of the HPGe survey, vertical profile samples may also be collected.

The IAG does not require the performance of a soil gas survey at IHSS 157.1. However, the available analytical data for well 4486, located in the northwest corner of the IHSS, indicate the presence of several VOCs in groundwater in the area. The source of these contaminants is not known, thus necessitating further investigation. The soil gas survey will analyze for the



following compounds and will note any other compounds which were detected but not calibrated for:

1,1,1-trichloroethane	perchloroethene	trichloroethene	chloroform
1,1-dichloroethane	acetone		

Analyses of groundwater samples from existing well 4486 and piezometers P115589 and P115689 will provide data which may be useful in assessing potential contamination associated with IHSS 157.1 (Figure 6-2). Groundwater samples from these locations will be analyzed for the constituents indicated in Table 6.4.

#### 6.3.1.9 Building 551 Radioactive Site (IHSS 158)

Stage 1 sampling efforts for IHSS 158 will consist of a visual inspection, surface radiological and soil gas surveys, surficial soil sampling, and sampling of existing groundwater monitoring wells and piezometers (Figure 6-4 and Table 6.3). The Stage 1 surface radiological and soil gas surveys for this IHSS will be performed on triangular grid spacings of 20 feet. The grid spacing for the soil gas survey was selected because the spills and other releases associated with this IHSS are believed to be relatively small. The available information regarding releases at this IHSS indicate that these releases occurred prior to the area surrounding Building 551 being paved. Thus, the investigation of this IHSS will focus on potential contamination of soils beneath the pavement. Much of this IHSS is located beneath the northern addition of Building 551. These investigations will be conducted around the perimeter of the building to the extent possible. The area to be investigated will consist approximately of the area outside of the foundation of Building 551 from the junction between the original building and the northern addition north to Sage Avenue and from Sixth Avenue on the west side of the building to IHSS 117.2 east of the building (Figure 6-4). Much of the area north and east of the building is paved

and will require holes cut through the pavement prior to initiating these surveys. In addition, the presence of several trailers and loading docks on the western side of the building necessitate that the survey grids be adjusted to maximize the coverage of the surveys in those areas.

The surface radiological survey will be performed with a tripod-mounted HPGe instrument over unpaved areas and with the HPGe instrument placed directly over access holes in the pavement in paved areas. Subsequent to the HPGe survey, surficial soil samples will be collected from six locations for analysis of TAL metals (Figure 6-4). At one of these sampling sites, a surficial soil sample will also be collected for analysis of radionuclides with a laboratory HPGe to confirm the results of the HPGe survey. This sample will be split and sent to a radiochemistry laboratory for analysis. Depending on the results of the HPGe survey, vertical profile samples may also be collected.

The soil gas survey will analyze for the following compounds and will note any other compounds which were detected but not calibrated for:

IAG Required

1,1,1-trichloroethane	perchloroethene	acetone	trichloroethene
toluene	benzene	carbon tetrachloride	

Indicated by Available Data

ethylbenzene	2-butanone	carbon disulfide	dichloromethane	total xylenes
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Analyses of groundwater samples from existing piezometers P115589, P115689, P214689, and P215789 will provide data which may be useful in assessing potential contamination associated

with IHSS 158 (Figure 6-2). Groundwater samples from these piezometers will be analyzed for the constituents indicated in Table 6.4.

#### 6.3.1.10 Waste Drum Peroxide Burial (IHSS 169)

As discussed in Sections 2.2.1.10 and 6.3, the documentation obtained during the preparation of this work plan indicates that the release described as IHSS 169 did not occur in the location previously indicated but is the same as IHSS 191. Regardless of the location of this incident, it is not likely that there would be detectable impacts attributable to it. Therefore, no further investigation of IHSS 169 is proposed.

#### 6.3.1.11 Solvent Burning Ground (IHSS 171)

Stage 1 sampling efforts for IHSS 171 will consist of a visual inspection, surface radiological and soil gas surveys, surficial soil sampling, sampling of the sump within the IHSS, and sampling of existing groundwater monitoring wells and piezometers (Figure 6-6 and Table 6.3). The Stage 1 surface radiological and soil gas surveys for this IHSS will be performed on triangular grid spacings of 20 feet. The grid spacing selected for the soil gas survey is based upon the relatively small size of areas of contamination expected to be associated with this IHSS. The area to be investigated will extend from Fourth Street east to the driveway to Building 331 and from Sage Avenue south approximately 100 feet to the base of a small slope to connect with the investigations of the southern portion of IHSS 134 (see Section 6.3.1.5). The surface of this area has not been paved and should not pose significant problems to the performance of these investigations.

The surface radiological survey will be performed with a tripod-mounted HPGe instrument over the entire area. Subsequent to the HPGe survey, surficial soil samples will be collected from four

locations for analysis of lithium and magnesium (Figure 6-6). At one of these sampling sites, a surficial soil sample will also be collected for analysis of radionuclides with a laboratory HPGe to confirm the results of the HPGe survey. This sample will be split and sent to a radiochemistry laboratory for analysis. Depending on the results of the HPGe survey, vertical profile samples may also be collected.

The soil gas survey will analyze for the following compounds and will note any other compounds which were detected but not calibrated for:

IAG Required

1,2-dichloroethane	perchloroethene	trichloroethene	chloroform
carbon tetrachloride	methylene chloride		

Indicated by Available Data

carbon disulfide	acetone
------------------	---------

As discussed in Section 2.1.1.11, an open sump located within IHSS 171 has contained standing water with an oily sheen on its surface during several site visits from November 1991 to March 1992. If water is present in the sump, the water will be sampled and analyzed for TCL volatiles and semivolatiles, TAL metals, and radionuclides (Table 6.4).

Analyses of groundwater samples from existing piezometers P114989, P114889, and P114789 will provide data which may be useful in assessing potential contamination associated with IHSS 171 (Figure 6-2). Groundwater samples from these piezometers will be analyzed for the constituents indicated in Table 6.4.

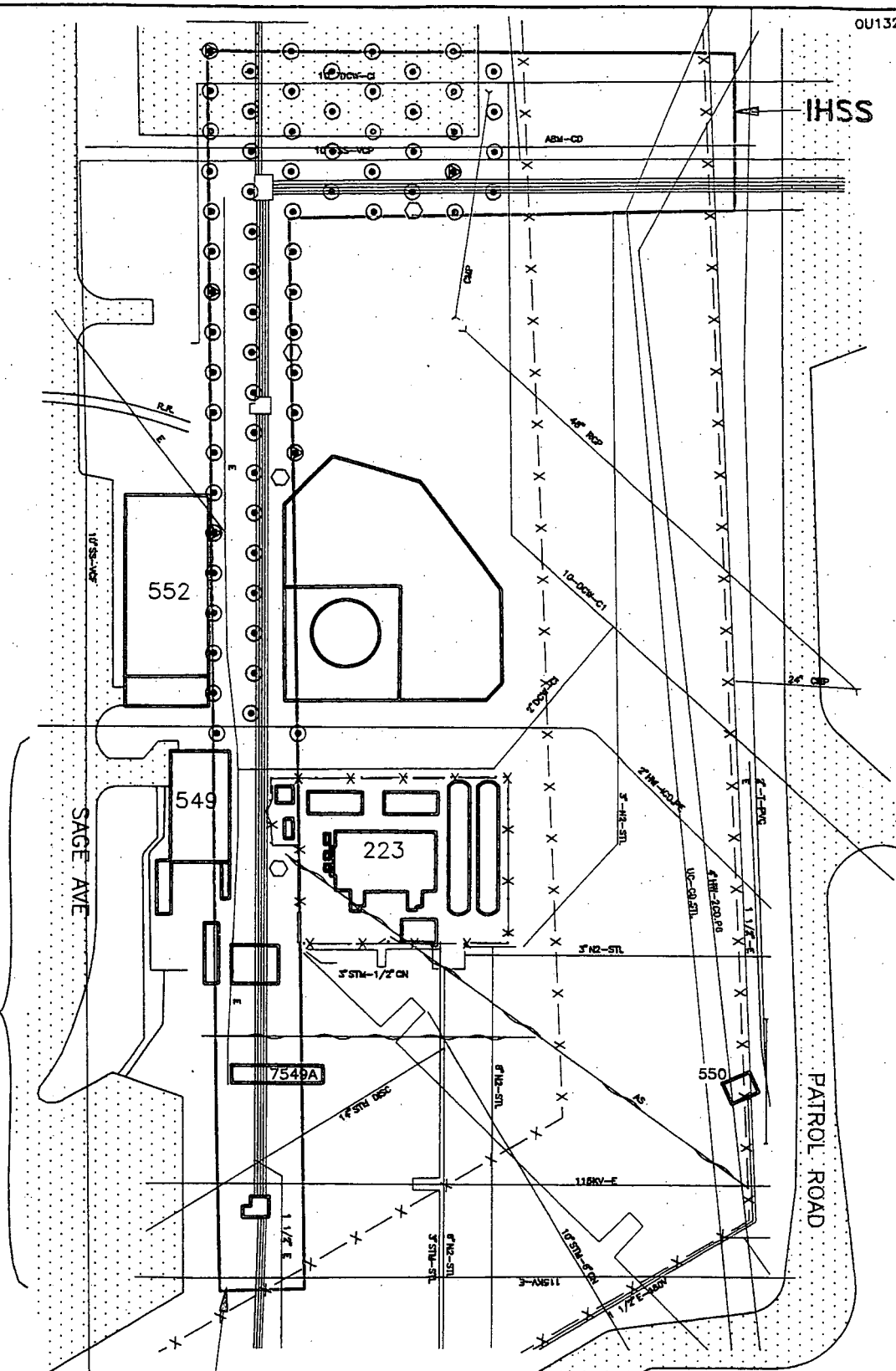
#### 6.3.1.12 Valve Vault (IHSS 186)

Stage 1 sampling efforts for IHSS 186 will consist of a visual inspection, surface radiological and soil gas surveys, surficial soil sampling, two soil borings, and sampling of existing groundwater monitoring wells and piezometers (Figure 6-10 and Table 6.3). The Stage 1 surface radiological and soil gas surveys for this IHSS will be performed on triangular grid spacings of 20 feet. Although the area potentially affected by the releases associated with this IHSS was relatively large, considerable excavation of soils in the area has occurred in response to these releases. Thus, the remaining contamination may occur in smaller areas necessitating the smaller grid spacing selected for the soil gas survey. The area to be surveyed will extend from the Protected Area south to Valve Vault 13 and then east to connect with IHSS 117.1 (Figure 6-10). The area to be surveyed is unpaved and should not pose significant problems to the performance of these surveys with the exception of adjustments in grid spacing to account for the valve vault, Building 231, and utilities in the area. The portion of this IHSS that extends into the area covered by IHSS 117.1 will be surveyed, both surface radiological and soil gas, under the planned program for IHSS 117.1 (Section 6.3.1.1). The Stage 1 investigation of IHSS 186 will not extend into the Protected Area. If the results of Stage 1 indicate that sampling within the Protected Area is necessary, a sampling program will be developed for implementation during Stage 2, or that portion of the IHSS will be transferred into a Protected Area investigation.

The surface radiological survey will be performed with a tripod-mounted HPGe instrument over the entire area. At five locations, a surficial soil sample will also be collected for analysis of radionuclides with a laboratory HPGe to confirm the results of the HPGe survey (Figure 6-10). Two of these samples will be split and sent to a radiochemistry laboratory for analysis. Depending on the results of the HPGe survey, vertical profile samples may also be collected.

IHSS 186

SOIL GAS & SURFACE  
RADIOLOGICAL SURVEY  
WILL BE DONE AS PART  
OF IHSS 117.1 SURVEY



IHSS 186

- HPGe Station
- Soil Gas Survey Location
- △ Surficial Soil Sample
- Borehole Location

Note: Vertical profile samples may be taken at some HPGe stations  
contingent upon HPGe results.

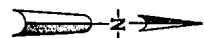
Refer to Fig. 2-2, MASTER LEGEND, for explanation of symbols.

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**FIGURE 6-10**

**IHSS LOCATION & UTILITIES MAP  
WITH PROPOSED SAMPLING LOC'S  
IHSS 186**



0 40 80  
Feet

SCALE: 1" = 80'  
SCALE APPROXIMATE



The IAG does not require the performance of a soil gas survey at IHSS 186. However, the available analytical data for well P114789, located near the southern edge of the IHSS, indicate the presence of several VOCs in soils in the area. The source of these contaminants is not known, thus necessitating further investigation. The soil gas survey will analyze for the following compounds and will note any other compounds which were detected but not calibrated for:

benzene	carbon disulfide	ethylbenzene	toluene
total xylenes	acetone		

Four soil borings will be drilled adjacent to the process waste lines in the area believed to have been contaminated by releases around Valve Vault 12 (Figure 6-10). One boring will be located between Valve Vault 12 and the retaining wall around Tanks 231A and 231B where the 1986 release was first detected. One boring will be located approximately 18 feet west of the valve vault near the edge of an area believed to have been excavated in response to the 1986 release. The remaining borings will be placed between Valve Vault 13 and the Protected Area and east of Valve Vault 12 between Buildings 223 and 549. Both borings will be drilled to a depth of 10 feet which is the approximate depth of the 1986 release. Each boring will be sampled in accordance with the specifications provided in Section 6.3.2 for Stage 2 borings with the following exceptions. Compositing samples will also be analyzed for nitrate. Analysis of radionuclides in samples from these borings will be performed onsite with a laboratory HPGe.

Analyses of groundwater samples from existing piezometers P114789 and P214689 will provide data which may be useful in assessing potential contamination associated with IHSS 186 (Figure 6-2). Groundwater samples from these piezometers will be analyzed for the constituents indicated in Table 6.4.

#### 6.3.1.13 Caustic Leak (IHSS 190)

As discussed in Sections 2.2.13 and 6.3, it is unlikely that any impact attributable to releases within this IHSS would be detectable. Therefore, no further investigation of this IHSS is proposed in this Work Plan. However, the Central Avenue Ditch, which is included in a portion of this IHSS, will be investigated within the integrated Field Sampling Plan to be developed. This plan will be incorporated into the Work Plan for Operable Unit No. 12 as a technical memorandum. The integrated Field Sampling Plan's applicability to OU13 will be addressed in the technical memorandum prepared at the end of Stage 2, and the results will be incorporated into the OU13 RFI/RI report.

#### 6.3.1.14 Hydrogen Peroxide Spill (IHSS 191)

As discussed in Sections 2.2.14 and 6.3, it is not likely that there would be detectable impacts attributable to the release of hydrogen peroxide within this IHSS. Therefore, no further investigation of this IHSS is proposed.

### 6.3.2 Stage 2 Investigation

Upon completion of Stage 1, the data collected during the screening surveys and measurement of radionuclides with the onsite laboratory HPGe will be evaluated and presented in a technical memorandum. This technical memorandum will provide the details of the Stage 2 investigation. The Stage 2 investigation will be performed to confirm the results of Stage 1 and to further define any contamination detected during Stage 1. Stage 2 will consist of the drilling of boreholes at locations indicated by Stage 1 screening surveys. Because of the turn-around time involved with obtaining results of the laboratory analyses of subsurface and surficial soil samples,

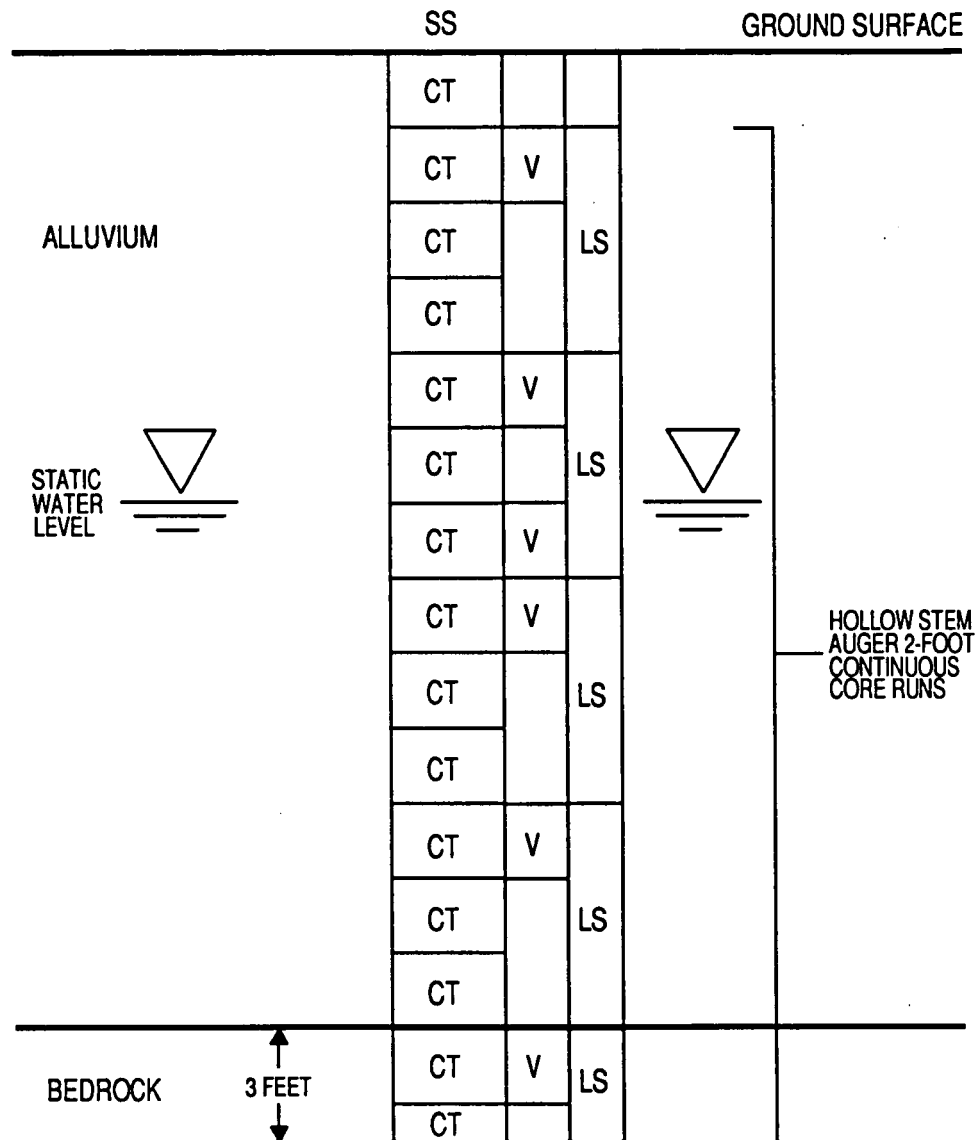
it is not anticipated that borings will be drilled during Stage 2 to investigate contamination indicated by those samples.

As indicated in Figures 6-1A to 6-1D, with the exception of IHSS 152, Stage 2 will involve the drilling of one or two boreholes within most IHSSs. For those IHSSs where no contamination was detected by Stage 1 activities, one borehole will be drilled to confirm the nonpresence of contamination. This borehole will be located at one of the surface radiological and soil gas survey sampling points and will be located at the point most likely to be contaminated based on the history of the site. For those IHSSs where contamination is detected by the Stage 1 surveys, boreholes will be drilled at the location of the highest level of contamination detected by each survey. The number of boreholes drilled will depend on whether the location of the highest level of contamination detected by the radiation survey and that detected by the soil gas survey coincide. Therefore, a maximum of two boreholes may be drilled at each IHSS. Any additional borings that may be required, based on the analysis of subsurface and surficial soil samples taken during Stage 1, will be addressed in the technical memorandum prepared at the completion of Stage 2. These borings, if required, will be installed during Stage 3.

Three borings will be drilled around Tank 221 in IHSS 152 in order to delineate contamination that has resulted from releases that have occurred. The locations of these borings will be determined by the results of the soil gas analyses and will be presented in the technical memorandum prepared at the end of Stage 1.

All boreholes will be drilled to a depth of six feet into weathered bedrock. If the weathered bedrock encountered in any borehole is sandstone, the borehole will be drilled through the sandstone to at least six feet into the next bedrock horizon. Figure 6-11 graphically illustrates the samples that will be taken from each borehole as described in the following paragraphs.

# TYPICAL BOREHOLE



## LEGEND

- CT 2-FOOT CONTINUOUS HOLLOW STEM AUGER CORE RUN
- LS 6-FOOT COMPOSITE LABORATORY SAMPLE FOR TAL METALS, TCL SEMIVOLATILES AND RADIONUCLIDES ANALYSIS
- SS SURFACE SCRAPE SAMPLE FOR TAL METALS AND RADIONUCLIDES ANALYSIS
- V DISCRETE LABORATORY SAMPLE FOR TCL VOLATILE ANALYSIS

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FIGURE 6-11  
Borehole Schematic Showing  
Lithologic and Chemical Sampling

**TYPICAL BOREHOLE**

SS                      GROUND SURFACE

ALLUVIUM

STATIC WATER LEVEL

BEDROCK

3 FEET

HOLLOW STEM  
AUGER 2-FOOT  
CONTINUOUS  
CORE RUNS

**LEGEND**

- [CT] 2-FOOT CONTINUOUS HOLLOW STEM AUGER CORE RUN
- [LS] 6-FOOT COMPOSITE LABORATORY SAMPLE FOR TAL METALS, TCL SEMIVOLATILES AND RADIONUCLIDES ANALYSIS
- [SS] SURFACE SCRAPE SAMPLE FOR TAL METALS AND RADIONUCLIDES ANALYSIS
- [V] DISCRETE LABORATORY SAMPLE FOR TCL VOLATILE ANALYSIS

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**FIGURE 6-11**  
Borehole Schematic Showing  
Lithologic and Chemical Sampling

Final  
October 9, 1992

Surface scrape samples will be taken at the location of each borehole prior to initiating drilling. These samples will be analyzed for TCL semivolatiles, radionuclides and TAL metals (Table 6.4). At locations that are paved, instead of collecting a surface scrape, a sample of native material will be taken approximately 4 inches below any base material that underlies the asphalt. This sample will be analyzed for the same constituents as surface scrapes.

In each borehole, discrete samples will be taken at 4-foot intervals during drilling for analysis of TCL volatiles (Figure 6-11). Samples for TCL volatile analyses will also be taken at the water table and at the alluvium-bedrock contact. Composite samples will be collected in each borehole from every 6-foot interval for analysis of TCL semivolatiles, TAL metals and radionuclides. All geologic materials will be continuously logged during drilling and 5 samples of alluvium and 5 samples of bedrock will be taken from boreholes throughout OU13 for physical analyses (Section 6.5.2). All sampling activities will be conducted in accordance with EG&G SOPs (Table 6.3).

Where boreholes are being drilled at the location of the highest level of contamination detected in the Stage 1 surveys, groundwater samples will be collected from the borehole using the Hydropunch®, or equivalent, technology. An SOP for the Hydropunch®, or equivalent, technology will be developed as part of the Field Implementation Plan. The Hydropunch® will be lowered inside the hollow stem auger and then pushed or driven to a depth of at least 5 feet below the water table, if possible. Water samples collected will be analyzed for TCL volatiles and semi-volatiles, TAL metals, radionuclides, and anions (Table 6.4). Field measurements of pH, temperature, and specific conductance will also be performed.

Upon completion of borehole sampling activities, all boreholes will be plugged and abandoned in accordance with EG&G SOPs (Table 6.3). All access holes cut into pavement will be patched with the proper material. If it is determined that a borehole should be completed as an alluvial monitoring well for risk assessment or contaminant characterization, it will be completed at this

time in accordance with EG&G SOPs (Table 6.3). Any wells installed during Stage 2 will be analyzed for the constituents specified in Table 6.4. The wells will be sampled once as part of the RFI/RI. Subsequent sampling will be conducted under EG&Gs sitewide monitoring program.

Due to access problems at certain IHSSs, it may not be possible to install boreholes in the locations indicated by the Stage 1 activities. Under these circumstances alternate locations for the boreholes will be evaluated based upon the results of Stage 1. For example, based upon the present location of fuel oil Tanks 221 and 224 within bermed areas in IHSSs 152 and 117.3 it is unlikely that boreholes can be drilled inside of the berms for these tanks. If contamination is detected during Stage 1 activities at these IHSSs, boreholes will be drilled outside of the bermed areas in those locations where the greatest potential exists for detecting such contamination.

Upon the completion of Stage 2, the results of Stages 1 (including analyses of subsurface and surficial soil samples and groundwater samples) and 2 will be fully evaluated to determine if further investigation of each IHSS is necessary. If the data collected do not indicate that contamination exists at a particular IHSS, no further investigation of that IHSS will be necessary. If the borehole and groundwater data collected indicate that contamination exists at an IHSS, then the Stage 3 investigation of that IHSS will be initiated. The existence of contamination will be based on background concentrations provided in the Background Geochemical Characterization Report as described in Section 2.2 of this Work Plan. The results of Stages 1 and 2 and recommendations for further investigation will be documented in a technical memorandum. This technical memorandum will summarize the results collected and will outline the scope of the Stage 3 investigation, if necessary, for each IHSS, particularly if Stage 3 will require activities that are not described in this Work Plan. In addition, if the information obtained during Stages 1 and 2 indicates that a vadose zone monitoring program is required at any OU13 IHSS(s), the details of this program will be included in this technical memorandum.

### 6.3.3 Stage 3 Investigation

The focus of the Stage 3 investigation will be to attempt to determine migration of contamination detected during Stages 1 and 2. The scope of the Stage 3 investigation is largely dependent upon the results of the Stage 1 and Stage 2 investigations. The number, location, and types of sampling points required cannot be precisely defined until Stages 1 and 2 have been completed and the data collected fully evaluated. The exact sampling locations will be determined on a case-by-case basis, taking into account the following factors:

- Environmental fate and transport of the specific contaminants;
- Contaminant concentrations;
- Expected depth to water table and bedrock;
- Nature of alluvium;
- Presence of any subcropping sandstone units in the bedrock; and
- Other pertinent data.

For scoping purposes, it is assumed that two alluvial groundwater monitoring wells will be required to be installed at each IHSS determined to be a source of contamination in Stages 1 and 2. One well upgradient and one well downgradient of these IHSSs will be installed. Whenever possible, existing wells and piezometers will be used for the Stage 3 investigation. Figure 6-12 provides preliminary locations of new wells to be installed and identifies those existing wells or piezometers that may be used during Stage 3. These locations will likely change based on the results of the Stage 1 and Stage 2 investigations and due to access problems. Based on the preliminary well locations identified in Figure 6-12, it is estimated that a maximum of 17 new wells will be installed during Stage 3. It is also estimated that a maximum of 10 existing wells and piezometers will be sampled during Stage 3. The final numbers and locations of wells to



be installed will be specified in the technical memorandum prepared at the end of Stage 2. As discussed in Section 6.3.2, additional borings may be required in Stage 3. The need for and locations of these borings will be specified in the technical memorandum.

During the drilling of new wells, borehole samples will be collected for analysis. The intervals sampled and the analytes for each sample will be the same as those defined above for Stage 2 (Table 6.4). If the Stage 1 and Stage 2 investigations indicate that a less extensive list of analytes will be required at any location, the analytes for samples obtained at that location will be specified in the technical memorandum submitted at the completion of Stage 2.

Groundwater samples will be collected from each well and analyzed for the list of constituents identified in Table 6.4. As with borehole samples, if a less extensive suite of analytes is required, the analytes for groundwater samples will be specified in the technical memorandum submitted at the completion of Stage 2. Samples will be collected from each new well immediately upon completion. Samples from existing wells and piezometers will be collected once at the time the Stage 3 investigation is initiated. Subsequent groundwater sampling will be performed as part of the site-wide monitoring program and will be arranged for by EG&G.

#### 6.4 SAMPLING EQUIPMENT AND PROCEDURES

The following sections describe the sampling equipment and procedures to be followed in general terms. Details regarding each of the sampling procedures is provided in the SOPs referenced in the following sections and listed in Table 6.3.

##### 6.4.1 Radiological Survey Procedure

Sampling locations are IHSS-specific and are discussed in Section 6.3. Radiological surveys will be conducted on 20-ft grids at all OU13 IHSSs requiring such surveys. The established grids will

provide approximately 90 percent coverage of unpaved portions of IHSSs and paved portions of IHSSs where a survey of the pavement is planned (see Section 6.3.1). At IHSSs where radionuclide concentrations in the soil beneath pavement are of interest, the HPGe detector will be placed directly over access holes cut in the pavement. These surveys will be performed using a tripod-mounted high purity germanium (HPGe) gamma ray detector developed for high resolution spectroscopy. The HPGe has a broad energy range, exhibits high resolution, excellent gain stability, moderate area averaging, and the ability to identify and quantify all gamma-emitting radionuclides. The HPGe detector provides radionuclide concentrations in soil in picoCuries per gram (pCi/g) of gamma-emitting radionuclides including, but not limited to, potassium-40, radium-226, thorium-232, cesium-137, americium-241, plutonium-239, -240, and -241, and uranium-233, -234, -235, and -238. Tritium and strontium-90 are not detected using this method. The SOP for the HPGe is presently being finalized and will be available prior to any OU13 field work. A modification to this SOP will be required for surveys of areas where the detector will be placed over holes in the pavement. Other equipment requirements are listed in Section 5.2 of SOP FO.16

An additional component of the radiological survey described above includes real time measurement of radionuclide concentrations in surficial soils and in vertical profile samples using a laboratory HPGe detector. Surficial soils and vertical profile samples collected via procedures in Section 6.4.3 will be surveyed with a laboratory detector to obtain radionuclide concentrations. The samples will be held for 30 days in a closed container to allow radon gas to equilibrate with parent radionuclides present in the soil. After the 30-day period, the radon activity measured will be representative of radionuclides, particularly radium, present in the soil sample.

#### 6.4.2 Soil Gas Survey

Real time soil gas sampling will be conducted at specific OU13 IHSSs presented in Section 6.3 according to procedures in SOP GT.9. Soil gas samples will be collected through a 1-inch diameter stainless steel probe rod driven with a hydraulic rig mounted on a vehicle. In paved locations, an access hole will be cut through the pavement prior to driving soil gas probes. In areas where vehicle access is not possible, the insertion of the soil gas probes by hand will be attempted. Soil gas samples will be collected at an approximate depth of 5 feet through tubing placed through the center of the rod. Samples collected through the tube will be immediately injected into the mobile laboratory for volatile organic compound analysis. Alternative soil gas techniques, such as passive collection methods, may be utilized if site conditions warrant it. Detection limits for soil gas analysis are specified in Table 5.3.

#### 6.4.3 Surficial Soil Sampling Procedure

Surficial soil sampling for radionuclide and metal analysis will be conducted in accordance with SOP GT.8 using two methods depending on the presence of pavement or concrete. The Rocky Flats sampler will be used to collect surficial soils for radionuclide analysis at OU13 IHSSs that are not covered by asphalt or concrete. At survey points covered with pavement, a single 0- to 2-in grab will be collected after the pavement has been cored, preferably with a plug-type sampler. Samples to be analyzed for nonradioactive parameters will be collected with a stainless steel scoop or plug-type sampler as described in OU1 Technical Memorandum 5. An SOP will be developed to describe sampling for radionuclides and other parameters from beneath paved areas.

The samples will be analyzed on site with the HPGe detector for radionuclides. Surface samples representing a range of radionuclide concentrations will be surveyed with the detector and sent

to an offsite laboratory for radionuclide analysis and verification. Surficial soil samples from selected IHSSs will also be submitted to an offsite laboratory for determination of TAL or specific metals.

#### 6.4.4 Borehole Drilling and Soil Sampling Procedures

Borings will be drilled to determine the geotechnical characteristics of the soil, to further investigate trends identified in screening tasks, to collect samples for physical and chemical analysis, and to install monitoring wells. Before any boreholes are drilled, utilities will be located and the drill site will be cleared in accordance with SOP GT.10.

Borings drilled for the purpose of documenting soil contamination will be drilled to the water table or six feet below the alluvial-bedrock contact, whichever is encountered first. Drilling the six-foot bedrock interval will allow a complete sample representative of bedrock conditions to be collected and analyzed. If the bedrock encountered in any borehole is sandstone, the borehole will be advanced through the sandstone to at least six feet into the next bedrock horizon. In monitoring well borings, soils collected from beneath the water table will not be submitted for chemical analysis, and borings will be advanced only three feet below the bedrock contact.

Hollow-stem auger drilling will be conducted in accordance with SOP GT.2, except where material is impenetrable with this method. If augering is ineffective, rotary drilling will be used in accordance with SOP GT.4. Rotary drilling will only be used in situations where material is impenetrable, with hollow-stem augering the method of choice. At locations with shallow borings where the drill rig cannot enter, hand augers will be used in accordance with guidelines in SOP GT.2 and GT.8.

All drill cuttings and soil samples will be surveyed for radionuclides and organic vapors in accordance with SOP FO.15, Use of Photoionizing and Flame Ionizing Detectors, and SOP FO.6, Field Radiological Measurements. Investigation-derived wastes, such as drill cuttings and residual samples, will be handled according to guidelines in SOP FO.8 and FO.9.

All equipment must be decontaminated before and after drilling and sampling takes place in accordance with the procedures outlined in the SOP FO.3 and FO.4. Decontamination water will be handled according to guidelines in SOP FO.7.

All of the borings not completed as monitoring wells will be grouted and abandoned immediately after drilling in accordance with procedures outlined in SOP GT.5. Procedures specified in this SOP are designed to prevent vertical migration of contaminants after abandonment.

Soil and bedrock samples will be collected during drilling for visual logging in accordance with SOP GT.1 and for chemical and physical analysis in accordance with SOPs GT.2 and FO.13. The soil and bedrock samples will be collected using a hollow-stem auger with a continuous-core sampler. Continuous core will be collected for geologic descriptions for the entire borehole depth. From this core, discrete, 2-ft samples will be submitted for laboratory volatile organic analyses (VOA) as shown in Figure 6-11. In addition, a discrete VOA sample will be collected at the water table and at the alluvium-bedrock contact. VOA soil samples should be collected in core liners that are capped and sealed upon recovery. In addition to the VOA samples, linear depth composite samples from the core will be submitted to the laboratory for analysis of the remaining chemical parameters from every consecutive 6 ft interval to the water table.

Soil samples for geotechnical analysis require a minimum amount of disturbance and will be collected in thin-walled metal tubes. The thin-walled metal tube will be driven into the undisturbed soils in advance of the hollow-stem auger, removed, and the tube sealed for transport

to the laboratory. Any changes to these geotechnical sampling procedures will be the subject of a document change notice.

#### 6.4.5 Asphalt/Concrete Sampling Procedure

Asphalt and/or concrete samples will be collected at some IHSSs where the potential exists that releases resulted in contamination of the asphalt/concrete. These samples will consist of two small-diameter (approximately 1-inch) core plugs. The core plugs will be collected using a hand core drill. The samples will be handled in accordance with SOP FO.13 and will be analyzed for gamma-emitting radionuclides with a laboratory HPGe.

#### 6.4.6 Installing and Sampling of Groundwater Monitoring Wells

All monitoring wells will be constructed with materials specified in SOP GW.6. A hollow-stem auger with an inner diameter a minimum of 4 inches larger than the well casing outer diameter will be used to drill the monitoring wells so as to produce a minimum annular space of 2 inches. Well construction techniques will follow procedures outlined in SOP GT.6. Investigation-derived wastes such as cuttings and residual samples will be handled in accordance with guidelines outlined in SOP FO.8.

Well construction techniques for all monitoring wells will follow procedures contained in SOP GT.6. Monitoring wells in high-traffic paved areas will be completed flush with the pavement. Wells in areas not exposed to vehicular traffic will be protected by the placement of steel posts around the monitoring wells, as described in SOP GT.6. Pressure grouting procedures will follow guidelines outlined in SOP GT.3. Additional equipment and materials that may be needed for monitoring well installation are listed in SOP GT.6, Section 5.1; other related SOPs are cross-referenced in Section 4.2 of SOP GT.6.

The wells will be developed no sooner than 48 hours and no longer than two weeks after completion and will not be sampled until at least two weeks after development. Water levels will be measured in all wells and recorded as outlined in SOP GW.1 and the appropriately cross-referenced SOP listed in Section 4.2 of SOP GW.1. After the water levels reach static conditions, the wells will be developed utilizing low-energy methods, such as an internal pump or bottom discharging bailer. Well development will follow procedures outlined in SOP GW.2.

Prior to groundwater sampling, three to five casing volumes of water will be purged from the well by either bailing or pumping. Purging procedures will follow those contained in SOP GW.6. Field parameters (pH, specific conductance, temperature) will be measured after every half casing volume is removed as described in SOP GW.6.

Groundwater samples will be collected in a manner that will minimize the amount of agitation or limit the exposure of the sample to the atmosphere. Groundwater sampling will be by bailing or the use of bladder or peristaltic pump. Samples will be collected, handled, and screened in accordance with SOP GW.6 and all related SOP.

All development and purge water will be handled in accordance with guidelines outlined in SOP FO.8. Equipment needed for groundwater sampling is listed in SOP GW.6.

Field parameters will be measured when each groundwater sample is collected. Specific conductance, pH, and temperature will be measured when groundwater samples are collected in accordance with SOP GW.6. Water level measurements will be conducted in accordance with SOP GW.1 and the appropriately cross-referenced SOP listed in Section 4.2 of this SOP GW.1.

Collection of groundwater samples with the Hydropunch® is not addressed by a current SOP. One will be developed prior to initiating sampling activities. Because a relatively large volume

of sample is required for the analyses specified in Section 6.3.3, the Hydropunch II®, or equivalent, sampler will be used. The Hydropunch II® will be lowered inside a hollow stem auger and then pushed or driven to a depth of at least 5 feet below the water table, if possible. Once the sampler is in place, the body of the sampler is pulled back allowing groundwater to flow into the tool. A small diameter bailer is then inserted into the tool for collection of a sample. Once sampling is complete, the tool can be pulled from the ground; however, a sacrificial screen remains in place.

#### 6.4.7 Sump Sampling Procedure

Standing water in the sump located within IHSS 171 will be sampled for the parameters specified in Section 6.3.1.10. The water in the sump will be collected in accordance with Section 5.3.3 of SOP SW.3. The water will be analyzed in the field for temperature, pH, and specific conductance.

#### 6.4.8 Surveying of Sample Locations

The locations of all radiometric survey points, soil gas survey points, borings, and surface sampling points will be measured with a steel tape prior to sampling or drilling. After sampling, drilling, or well installation, locations will be surveyed using standard land surveying techniques described in SOP GT.17. Horizontal accuracy will be  $\pm 0.5$  ft for surficial soil samples, soil gas survey points, and borings and  $\pm 0.1$  ft for temporary well point locations and wells. Three elevations will be determined for each well: ground surface, top of well casing, and top of surface casing.



## **6.5 SAMPLE ANALYSIS**

### **6.5.1 Soil Gas Analysis**

Soil gas samples will be analyzed for the parameters specified for each IHSS in Sections 6.3.1.1 to 6.3.1.11. The SOPs applicable to the analysis of soil gas samples are specified in Table 6.3. Detection limits for these analyses are specified in Table 5.3.

### **6.5.2 Borehole Samples**

#### **6.5.2.1 Chemical Analysis**

Borehole samples will be collected for chemical analysis from surficial materials and weathered bedrock, as discussed in Sections 6.3.2 and 6.3.3. Section 6.3.2 and Table 6.4 designate borehole samples for analysis and provide the chemical parameters that the samples will be analyzed for. The detection limits for these analyses are specified in Table 5.3.

#### **6.5.2.2 Physical Analysis**

Physical analysis of five samples of alluvium and five samples of bedrock from random boreholes throughout OU13 will be performed. Physical analysis on alluvium and bedrock samples will consist of classification (ASTM [American Society for Testing and Materials] D2488), moisture content (ASTM D2216), and dry density for intact samples (ASTM D2216). Laboratory classification tests will consist of grain size distribution (ASTM D422) (including hydrometer analysis) and Atterberg limits (ASTM D4318).

### 6.5.3 Groundwater Samples

Groundwater samples will be collected from existing wells and piezometers identified in Sections 6.3.1.1 to 6.3.1.11 and from new and existing wells and piezometers as identified in Section 6.3.3. Samples will be measured in the field for pH, specific conductance, and temperature in accordance with the procedure specified in Table 6.3. Table 6.4 lists the analytical parameters for groundwater samples for the Stage 1 investigation. Subsequent sampling iterations may require analyses of a less extensive suite of analytes as specified in Section 6.3.3. Laboratory analyses for dissolved metals will be performed on samples filtered in the field using a 0.45 m cellulose acetate filter prior to sample preservation.

### 6.5.4 Sample Containers and Preservation

The type of analysis and media to be sampled dictates the sample container volume and material requirements, preservation techniques, and holding times. Information relating to sample containers and preservatives is provided in SOP FO.13, Containerization, Preserving, Handling, and Shipping of Soil and Water Samples. The parameters specific to OU13 with the corresponding containers, preservative, and holding time are listed in Table 6.5.

### 6.5.5 Sample Handling and Documentation

Sample control and documentation is necessary to ensure the defensibility of data and to verify the quality and quantity of work performed in the field. Accountable documents include logbooks, data collection forms, sample labels or tags, chain-of-custody forms, photographs, and analytical records and reports. Specific guidance describing container labeling, decontamination, field packaging, chain-of-custody records, field data documentation, packaging and shipping is

TABLE 6.5  
SAMPLE CONTAINERS, PRESERVATION, AND HOLDING TIMES  
FOR SOIL AND WATER SAMPLES

SOIL SAMPLES			
Parameter	Container	Preservative	Holding Time
TAL Metals	1 x 250 ml wide-mouth glass jar	None	180 days <sup>1</sup>
TCL Volatiles	2 x 125 ml wide-mouth glass vials	Cool, 4 degrees C	7 days
TCL Semivolatiles	1 x 250 ml wide-mouth glass jar	Cool, 4 degrees C	7 days until extraction 40 days after extraction
Radionuclides	1 x 1 l wide-mouth glass jar	None	None
WATER SAMPLES			
Parameter	Container	Preservative	Holding Time
TAL Metals	1 x 1 l polyethylene bottle	Nitric acid pH<2; Cool, 4 degrees C	180 days <sup>1</sup>
TCL Volatiles	2 x 40 ml VOA vials with teflon-lined septum lids	Cool, 4 degrees C	7 days
TCL Semivolatiles	1 x 4 l amber glass bottle	Cool, 4 degrees C	7 days until extraction 40 days after extraction
Radionuclides	1 x 12.0 l polyethylene bottle	Nitric acid pH<2; Cool, 4 degrees C	180 days
Anions	1 x 1 l polyethylene bottle	Cool, 4 degrees C	28 days
Nitrate/nitrite	1 x 2 l polyethylene bottle	Sulfuric acid pH<2; Cool, 4 degrees C	28 days
pH, temperature, and specific conductance	In situ, beaker or bucket	None	Analyze immediately

<sup>1</sup> Holding time for mercury is 28 days

provided in SOP FO.13, Containerization, Preserving, Handling, and Shipping of Soil and Water Samples.

Field data and reporting requirements are discussed in detail in SOP FO.14 Field Data Management. In general the following procedures must be followed:

- Collection of data on pre-printed forms;
- Preliminary verification of the data;
- Technical verification by a qualified verifier;
- Data input into the Rocky Flats Environmental Data System (RFEDS);
- Verification of input;
- Archive and filing of data;
- Security of database and computers;
- Documentation of implementation of the referenced SOP; and
- Use of data management forms.

#### 6.5.6 Sample Designation

The Rocky Flats Environmental Data System (RFEDS) requires all sample designations to be consistent. Each sample designation will contain a nine-character sample number consisting of a two-letter prefix that relates to the type of sample collected (e.g. "SB" for soil borings, "SS" for surface soils), a unique five-digit number, and a two-letter suffix identifying the contractor. One sample number will be required for each sample generated, including quality control samples. Using this system, 99,999 unique sample numbers are available for each sample media

per contractor. Boring numbers will be developed independently of the sample number for a given boring; however, the boring number and sample number are linked so that data for particular samples can be related to the boring from which the sample was taken. These sample numbering procedures are consistent with the RFP sitewide QAPjP.

## 6.6 FIELD QC PROCEDURES

Sample duplicates, field preservation blanks, and equipment rinsate blanks will be prepared. Trip blanks will be obtained from the laboratory. The analytical results obtained for these samples will be used by the EMD project manager to assess the quality of the field sampling effort. The types of field QC samples to be collected and their application are discussed below. The frequency with which QC samples will be collected and analyzed is provided in Table 6.6.

Duplicate samples will be collected by the sampling team for use as a relative measure of the precision of the sample collection process. These samples will be collected at the same time, using the same procedures and equipment, and placed in the same types of containers as required for the samples. They will also be preserved in the same manner and submitted for the same analyses as required for the samples.

Field blanks of distilled water, preserved according to the preservation requirements (Section 6.5.4), will be prepared by the sampling team and will be used to provide any indication of any contamination introduced during field preparation. As indicated in Table 6.6, these QC samples are applicable only to samples requiring chemical preservation.

Equipment (rinsate) blanks will be collected from final decontamination rinsate to evaluate the success of the field sampling team's decontamination efforts on non-dedicated sampling equipment. Equipment blanks are obtained by rinsing cleaned equipment with distilled water

prior to sample collection. The rinsate is collected and placed in the appropriate sample containers. Equipment blanks are applicable to all analyses for water and soil samples and for organics analysis of soil gas samples, as indicated in Table 6.6. Equipment blanks for soil gas sampling will consist of blanks taken and analyzed to check background contamination in the sampling system and cartridges (see SOP FO.09).

Trip blanks consisting of ASTM Type II laboratory reagent water will be prepared by the laboratory technician and will accompany each shipment of samples for VOC analysis. Trip blanks will be stored with the group of samples with which they are associated. Analysis of the trip blank will indicate migration of VOCs or any problems associated with sample shipment, handling, or storage. Trip blanks for soil gas analysis will consist of an unused sample cartridge transported into the field with the sampling equipment. The trip blank cartridge will be handled in the same manner as a sample, but a sample will not be collected through this cartridge.

TABLE 6.6  
FIELD QC SAMPLE FREQUENCY

Sample Type	Type of Analysis	Media		
		Solids	Liquids	Soil Gas
Duplicates	Organics	1/10	1/10	1/10
	Inorganics	1/10	1/10	NA
	Radionuclides	1/10	1/10	NA
Field Preservation Blanks	Organics	NA	NA	NA
	Inorganics	NA	1/20	NA
	Radionuclides	NA	1/20	NA
Equipment Blanks	Organics	1/20*	1/20*	1PD
	Inorganics	1/20*	1/20*	NA
	Radionuclides	1/20*	1/20*	NA
Trip Blanks	Organics	NR	1/20	1/20
	Inorganics	NR	NR	NA
	Radionuclides	NR	NR	NA

NA = Not Applicable

NR = Not Required

1/10 = 1 QC sample per 10 samples collected

1/20 = 1 QC sample per 20 samples collected

1/20\* = 1 QC sample per 20 samples collected or 1 QC sample  
per day whichever is more frequent

1PD = 1 QC sample per day and prior to reuse of recleaned sampling equipment

ROCKY FLATS PLANT  
Phase I RFI/RI Work Plan  
Operable Unit 13  
100 Area

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Organization: Environmental Management

TITLE: Scheduling

Approved By:

02/01/93  
Effective Date

Michael J. McHugh  
Manager

10/9/92  
Date

## 7.0 TASKS AND SCHEDULING

The preliminary schedule for conducting the OU13 Phase I RFI/RI is summarized in Figure 7-1. The preliminary schedule includes the milestones established in the IAG and includes contingencies for regulatory review of a brief Technical Memorandum to be prepared after Stage 2 of the FSAP. The schedule does not address issues related to obtaining contractual authorization to proceed. Laboratory turn-around time for reporting analytical results is assumed to take 21 days; data validation is assumed to require an additional 30 days, and both have been factored into the preliminary schedule. Approximately two years will elapse from the time the Work Plan is implemented until the final RFI/RI Phase I report is issued.

Several key elements of the Work Plan overlap chronologically. This reflects both the flexibility designed into the Work Plan and the need to implement the Work Plan on an aggressive schedule.

Data validation will begin approximately one month after the site characterization task begins in anticipation that sufficient data will be generated from this stage of the RFI/RI until its completion. It will therefore be necessary to utilize a full-time data validation staff. Implementing data validation concurrent with site characterization will assist in the refinement of data collection procedures and in completing RFI/RI activities within the timeframe established in the IAG.



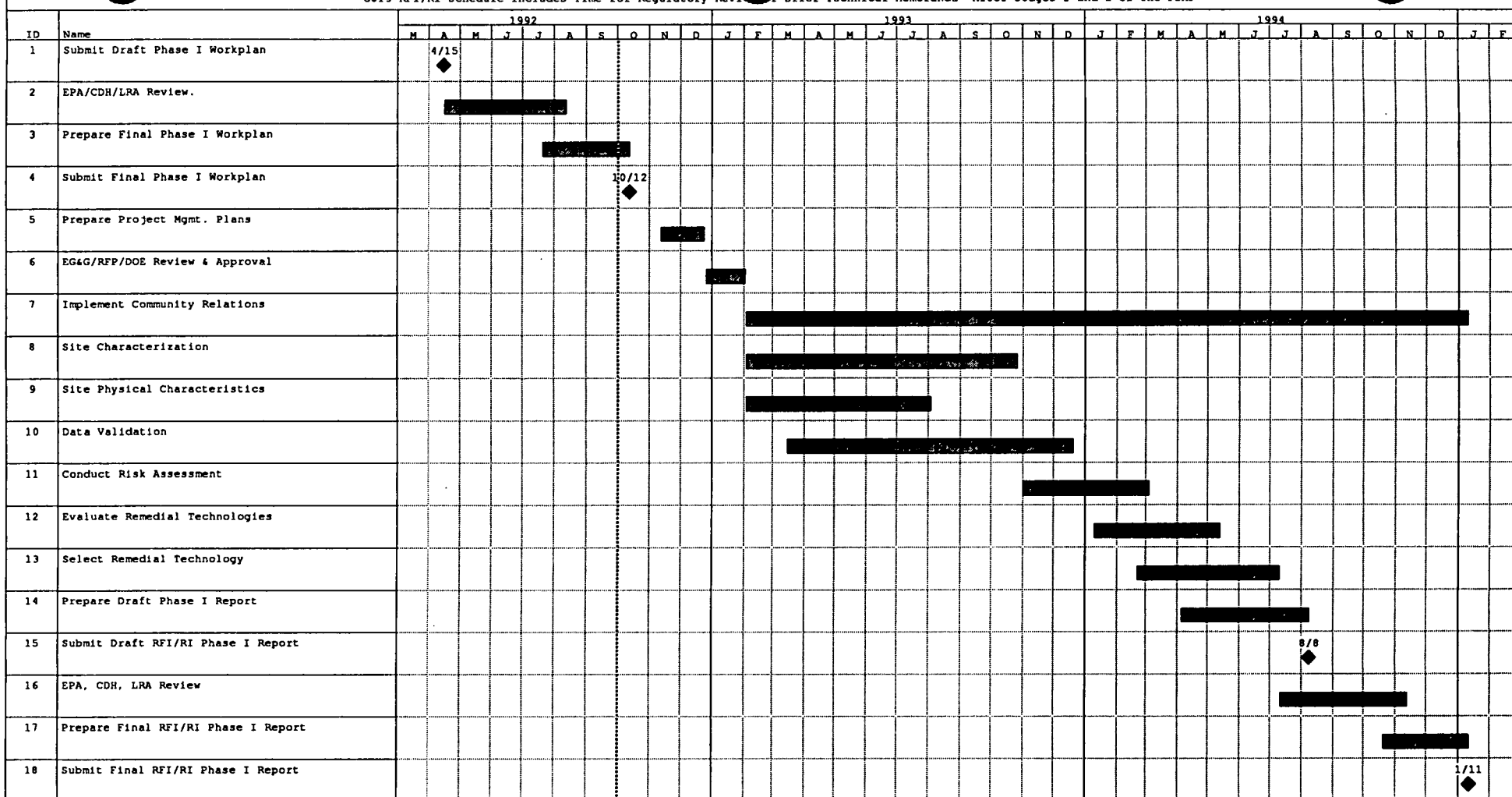


FIGURE 7-1

Critical

Noncritical

Progress

Milestone

Summary

Rolled Up

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**Environmental Management**

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Michael J. Fair  
**Manager**

10/9/92  
**Date**

## **8.0 HUMAN HEALTH RISK ASSESSMENT PLAN**

### **8.1 OVERVIEW**

#### **8.1.1 Regulatory Basis**

Section 300.430(d) of the National Contingency Plan (Federal Register March 8, 1990, p.8709) states that, as part of the remedial investigation, a human health risk assessment is to be conducted as part of a Baseline Risk Assessment (BRA) to determine whether contaminants of concern identified at the site pose a current or potential risk to human health and the environment in the absence of remedial action. This section describes the Human Health Risk Assessment components, including the following:

- Contaminant description;
- Exposure assessment;
- Toxicity assessment;
- Risk characterization; and
- Uncertainty analysis.

These components correspond to the four components within IAG required in Section VII.D.I for contaminant identification, exposure assessment, toxicity assessment, and risk characterization.

The uncertainty analysis is an additional requirement of the risk assessment procedures for assessing the level of confidence in risk estimates (EPA, 1989b).

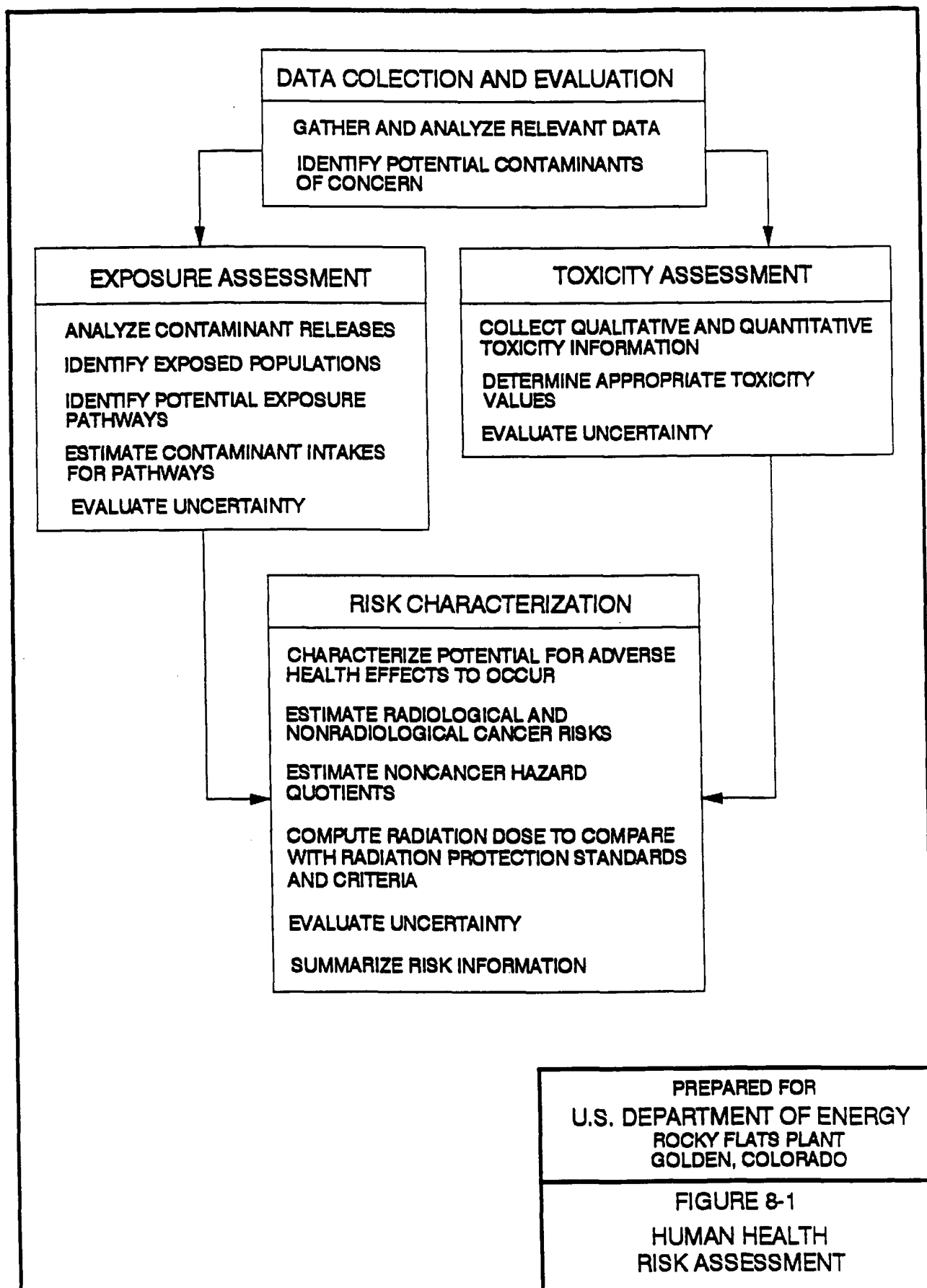
Figure 8-1 illustrates the basic Human Health Risk Assessment process and components. The objective of this assessment is to identify and estimate potential human health risks resulting from exposure to contaminants present in various environmental media within OU13. The Human Health Risk Assessment considers risks from both radiological and nonradiological contaminants. The EPA and DOE require a two-phase evaluation for the radiological portion of the assessment. The Human Health Risk Assessment will incorporate the two-phase analysis, which includes:

- The implementation of procedures established by the International Commission on Radiological Protection (ICRP) and adopted by the EPA used to estimate the radiation dose equivalent to humans from potential exposure to radionuclides through all pertinent exposure pathways: and
- The computation of health risk, based on the age-averaged lifetime excess cancer incidence per unit intake (and per unit external exposure) for radionuclides of concern. This data can also be used to assess dermal contact with surface soils.

Human Health Risk Assessment results will be used to determine if remedial actions are warranted at OU13 and, if so, what associated cleanup levels will be necessary to protect human health. Clean up levels are computed during the Feasibility Study.

A number of guidance and information documents will be used to provide direction for developing the Human Health Risk Assessment. These include:

- Risk Assessment Guidance for Superfund, Human Health Evaluation Manual Volume 1. (Part A). Interim Final. 1989. EPA/540/1-89/002 (EPA, 1989c), including Office of Solid Waste and Emergency Response (OSWER) Directive



9285.6-03 Human Health Evaluation, Supplemental Guidance: "Standard Default Exposure Factors";

- Guidance for Data Useability in Risk Assessment. Interim Final. 1990. EPA/540/G-90/008 (EPA, 1990);
- Superfund Exposure Assessment Manual. 1988. EPA/540/1-88/001 (EPA, 1988b);
- Procedures established by the ICRP and adopted by EPA in Federal Guidance Report No. 11 (EPA, 1988);
- Radiation Protection of the Public and the Environment, DOE Order 5400.5;
- Risk Assessment in the Federal Government; Managing the Process. 1983. National Academy Press, Washington, D. C.; and
- Publications of the National Council of Radiation Protection, International Council on Radiological Protection, United National Scientific Committee on the Effects of Atomic Radiation, as appropriate.

In addition to available national EPA guidance, supplemental Region VIII risk assessment guidance will be used, if applicable.

#### 8.1.2 Background of Site Contamination

In the OU13 there presently exists a total of 13 IHSSs. Historical quantitative data is nonexistent for these areas and only qualitative historical data is available (Appendix A).

Contaminants identified in the draft HRR at the OU13 IHSS and UBC include enriched and depleted uranium, plutonium, beryllium, chlorinated hydrocarbon solvents, chromates, nitric and sulfuric acids, carbon tetrachloride, and fuel oil. These compounds may occur in the groundwater, soils, ambient air, surface water, and sediments of OU13.

A comprehensive assessment of all contaminants of concern (COCs) and of the exposure pathways will be performed during OU13 RFI/RI activities. This assessment will conclude with a Technical Memorandum on exposure scenarios and a Technical Memorandum on computer modeling. These Technical Memoranda will be reviewed and approved by EPA and CDH.

Data needs and DQOs are presented in Section 5.0 of this work plan. Section 6.0 of this work plan describes how the data needs identified will be collected. The data needs and FSAP address the objectives described in Section 5.0 and include characterizing the nature and extent of contamination and the data collection necessary to assess the complete potential exposure pathways. The data to be collected and its use in the Human Health Risk Assessment include the following media sampling:

- **Soils:** Data characterizing vertical depth contaminant concentrations in OU13 will be used to support discussions of contaminant fate and transport and, ultimately, the exposure assessment.
- **Surficial Soils:** Surface soil data will be used to estimate exposure and risk through ingestion and, if necessary, estimate windborne particulate concentrations for subsequent inhalation exposures. This data can also be used to assess dermal contact with surface soils.
- **Surface Water and Sediments:** Data characterizing contaminants in surface water can be used to support discussions of contaminant fate and transport, in addition to estimating exposure and risk from ingestion or dermal contact with surface water and sediments, and inhalation of sediments.
- **Ground Water:** Data characterizing site-specific hydrogeology and potential contaminants in alluvial and confined groundwater systems can be used to support discussions of contaminant fate and transport in addition to estimating exposure and risk from ingestion, inhalation, or dermal contact with groundwater.
- **Air:** Data characterizing the potential for dispersion of contaminated sediments can be used to support discussions of contaminant fate and transport in addition to estimating exposure and risk from inhalation.

A comprehensive quantitative assessment of all contaminants of concern and potential exposure pathways will be performed as part of the RFI/RI. The remainder of this section generally describes the individual Human Health Risk Assessment components as they relate to the overall risk assessment.

## **8.2 CONTAMINANTS OF CONCERN**

The objective of this section is to describe the procedures to identify source-related contaminants present at OU13 at concentrations that could be of concern to human health. The contaminant description component and identification of COCs of the Human Health Risk Assessment summarizes historical and RFI/RI data collected at OU13, evaluates historical and RFI/RI data relative to performing the Human Health Risk Assessment, and uses this information to perform the hazard identification. The contaminant description section includes the following information:

- Data collection;
- Data evaluation; and
- Hazard identification.

### **8.2.1 Data Collection**

The objective of the data collection task is to summarize all data available for use in the Human Health Risk Assessment in preparation of further data evaluation activities. This step, then, identifies the historical data relevant to performing the Human Health Risk Assessment, assembles the RI data, and establishes data formats to facilitate data evaluation. The following data attributes are important to this step:

- Site description;
- Sample design with sample locations;
- Analytical method and detection limit;
- Results for each sample, including qualifiers;
- Sample quantification limits and/or detection limits for nondetects;
- Field conditions; and
- Sample documentation (for example, chain-of-custody and Standard Operating Procedures (SOPs)).

#### 8.2.2 Data Evaluation

Historical and RFI/RI data will be evaluated by using EPA's Guidance for Data Useability in Risk Assessment (EPA, 1990). The following data usability criteria may be applicable:

- Assessment of data documentation for completeness;
- Assessment of data sources for appropriateness and completeness;
- Assessment of analytical methods and detection limits for appropriateness;
- Assessment of sampling data quality indicators (completeness, comparability, representativeness, precision, and accuracy); and
- Assessment of analytical data quality indicators (such as spike recoveries, duplicates, and blanks) for completeness, comparability, representativeness, precision, and accuracy.

The RFI/RI data that can be used to support a quantitative Human Health Risk Assessment will be identified. Part of this evaluation will include the most appropriate summary process and



format. This will involve identifying statistical summary techniques that consider spatial and temporal data distributions, determining if arithmetic or geometric means are appropriate, and determining the appropriate method for dealing with nondetected values and qualified data. The data summary will include:

- The frequency of detection (number of positive detects/number of analyses) for each compound and sample location; and
- The minimum- and maximum-reported concentrations for each contaminant at each sample location.

Tentatively identified compounds (TICs) reported in the RFI/RI data will be evaluated relative to their usefulness in the Human Health Risk Assessment. It is anticipated that risks resulting from exposure to TICs will not be characterized because of the absence of specific contaminant identity and available toxicological information.

### 8.2.3 Hazard Identification

The objective of the hazard identification is to identify contaminants present at OU13 in concentrations high enough that may be of concern relative to human health considerations. The HRR identified uranium, plutonium, beryllium, chlorinated solvents, acids, and fuel oil within OU13. In addition to these contaminants, others may be identified based on RFI/RI analytical results. Criteria for performing the hazard identification include, but may not be limited to:

- Frequency of detection;
- Environmental media concentrations which exceed background concentrations; and
- comparison with Health/Environmental Criteria.

#### 8.2.4 Selection of Contaminants of Concern

A methodology for selecting contaminants of concern will be developed using the guidance from RAGS. Per the IAG, this methodology will be submitted to EPA/CDH for review and approval in the technical memorandum (TM) on Contaminants of Concern. This TM will be submitted prior to the required submittal of the Baseline Risk Assessment and will contain the chemicals to be evaluated in the risk assessment.

### 8.3 EXPOSURE ASSESSMENT

The objective of the exposure assessment is to determine how exposures to site contaminants could occur and to estimate the extent of exposure if it occurs. The exposure assessment includes several tasks:

- Characterization of the exposure setting relative to contaminant fate and transport and potentially exposed populations;
- Identification of exposure pathways based on source and release, exposure point and exposure route;
- Identification of potentially exposed populations and the dynamics of their exposure; and
- Identification of uncertainties associated with the exposure assessment that impact the risk characterization.

Exposure is defined as the contact of an organism with a contaminant or physical agent. The magnitude of exposure is determined by measuring or estimating the amount of a contaminant available at the exchange boundaries. When contaminants migrate from the site to an exposure point, or when a receptor directly contacts contaminated media, exposure can occur.

### 8.3.1 Conceptual Site Model

The conceptual site model developed for OU13 (Figures 2-30 and 2-31) will be used to evaluate primary and secondary contaminant sources and releases, and potential receptors and associated exposures. The models help to characterize the exposure setting relative to contaminant fate and transport mechanisms through exposed receptors. These models may be revised, based on RFI/RI data collected for the OU, to incorporate new information.

The potential adverse health effects due to OU13 will be determined. Human intakes of contaminants will be calculated separately for different exposure routes. Then, the total chronic intake by each route of exposure will be calculated by adding the intakes from each pathway. Total oral, inhalation, and dermal chronic exposures as well as external exposures from radionuclides will be estimated separately. Exposure concentrations will be estimated as described in Section 8.3.4 for a variety of reasonable exposure conditions in order to evaluate the range of plausible exposure concentrations. At a minimum, the exposure assessment will consider the estimated minimum, expected, and reasonable maximum exposure (RMaxE) concentrations. RMaxE concentrations are represented by the 95 percent upper confidence limit on the arithmetic average.

### 8.3.2 Contaminant Fate and Transport

The conceptual site model helps identify potential contaminant fate and transport mechanisms. These could include soil contaminants leaching to groundwater and subsequent transport, soil entrainment and downwind deposition, or surface runoff that transports surface soil downslope. Contaminant-specific characteristics affect fate and transport. Factors affecting the probability a contaminant will migrate include, but are not limited to, the following:

- Solubility;
- Partition coefficients;
- Vapor pressure;
- Henry's Law constant;
- Bioconcentration or dilution factors; and
- Half-life or degradation in the environment.

The evaluation of these factors will help determine if contaminants can migrate from their sources to potential receptors; not only those receptors identified under current use scenarios, but those identified under potential future exposure scenarios as well.

Models utilized for fate and transport evaluation will be described and submitted in a technical memorandum to the EPA and State of Colorado for review and approval as required by the IAG Section VII.D.1.b. The memorandum will include a summary of the data that will be utilized in these models. Representative data will be utilized and the limitations, assumptions, and uncertainties associated with the models shall be documented.

### 8.3.3 Exposure Pathways

By using the conceptual site model and information on contaminant fate and transport, exposure pathways can be identified. This information, combined with data on the physical site setting and potentially exposed site worker population, will be used to identify and evaluate complete exposure pathways. The Human Health Risk Assessment will consider only complete exposure pathways, those for which data support the presence of a source, release mechanism, transport mechanism, exposure route and affected receptor. Complete exposure pathways include the receptors and exposure route (ingestion, inhalation, dermal, and external irradiation).

As required by the IAG Section VIL.D.b, a technical memorandum will be submitted to EPA and the State of Colorado for review and approval concerning the exposure scenarios. The memorandum will describe the present, future, potential, and reasonable use scenarios. A description of the assumption made and the data used will be included.

#### 8.3.4 Exposure Point Concentrations

By using the data set identified as part of Subsection 8.2.2, exposure point concentrations will be estimated. Some data will be collected at the point of exposure. Other data collected at the source may be used in conjunction with a transport model to estimate expected concentration at some exposure point. Because modeling may add uncertainty, the work plan emphasizes collecting data at exposure points where possible even though these data provide only a snapshot of conditions in time and space

A statistical approach will be taken to characterize a range of exposure point concentrations for representative exposure scenarios and conditions. The initial step will be to evaluate and characterize the underlying statistical distribution (e.g., normal, lognormal, etc.) through classical methods such as histograms and goodness of fit tests, and similar summary statistics. Based on this initial assessment, suitable measures of central tendency and dispersion such as the mean, variance, and similar summary statistics will be developed. These measures will be used to characterize exposure point concentrations for different cases of interest such as: the expected case; the 95 percent lower confidence limit case (the Reasonable Minimum Exposure, RMinE); and the 95 percent upper confidence limit (the Reasonable Maximum Exposure, RMaxE) case.

### 8.3.5 Contaminant Intake Estimation

Contaminant intake or exposure is normalized for time and body weight, and is expressed as milligrams of chemical per kilogram of body weight per day (mg/kg/day). Radionuclide intake is expressed in picoCuries (pCi). Six basic factors are used to estimate intake: exposure frequency, exposure duration, contact rate, chemical concentrations, body weight, and averaging time. These factors are based on the types of exposure, for example, ingestion, inhalation, or dermal.

The RMinE, RMaxE, and average exposure point concentrations are used in conjunction with receptor activity patterns to estimate contaminant intake for each exposure route as appropriate. EPA guidance such as Risk Assessment Guidance for Superfund Volume I: Human Health Evaluation Manual Supplemental Guidance, Standard Default Exposure Factors Interim Final, March 25, 1991 (EPA, 1989c) will be consulted in developing bounding case exposure parameters to support an unbiased exposure assessment. Also, the averaging time for carcinogens and noncarcinogens differ.

Other standard contaminant intake rates established by the EPA that will be used, if appropriate, include the following:

- Soil ingestion rates based on age; and
- Inhalation rates based on activity levels.

Contaminant intake rates can also be estimated for dermal exposures. Of the three routes of exposure (ingestion, inhalation, and dermal), the greatest uncertainty is associated with dermal exposures.

### 8.3.6 Uncertainty in the Exposure Assessment

The ability to construct exposure scenarios for a site depends on the amounts and kinds of environmental data collected for that purpose. Some uncertainty is inherent in environmental data collection. The numbers and kinds of uncertainties included in the exposure assessment directly impact the risk characterization; many professional judgements impact the identification and description of physical site attributes that affect exposure and activity patterns. One of the major areas of uncertainty in the exposure assessment is the prediction of human activities that lead to contact with environmental media and exposures to site-related contaminants. This section of the Human Health Risk Assessment will identify and evaluate how site attributes related to environmental sampling and analysis, fate and transport modeling, and exposure parameter estimation and assumptions about them affect uncertainty relative to assessing risk.

## 8.4 TOXICITY ASSESSMENT

The objective of the toxicity assessment is to describe the contaminants considered in the Human Health Risk Assessment relative to their potential to cause harm. The toxicity assessment has two general steps. The first determines what adverse health impacts, if any, could result from exposure to a particular contaminant. These are typically classified as carcinogenic and noncarcinogenic health effects. The second step, the dose-response evaluation, quantitatively examines the relationship between the level of exposure and the incidence of adverse health effects.

Toxicity depends on the dose or concentration of the substance (dose-response relationship). Toxicity values are a quantitative expression of the dose-response relationship for a contaminant and take the form of reference doses (RfD) and cancer slope factors, both of which are specific

to exposure via different routes. If the inhalation pathway is a potential exposure route, inhalation Reference Concentrations (RfCs) will be utilized.

Two sources of toxicity values are currently available for chemicals and radionuclides. The primary source is the EPA's Integrated Risk Information System (IRIS) data base, which contains up-to-date health risk and regulatory information. IRIS contains only those RfDs and slope factors that have been verified by EPA work groups and is considered by EPA to be the preferred source of toxicity information for chemicals.

Following IRIS, the most recently available Health Effects Assessment Summary Tables (HEAST), issued by EPA's Office of Research and Development, will be consulted to identify interim RfDs and slope factors for chemicals and radionuclides. IRIS is the primary source for EPA derived toxicity values and HEAST is the secondary source. Other sources such as ICRP and National Commission on Radiological Protection (NCRP) will also be consulted.

Toxicity values for substances identified in OU13 which lack EPA toxicity values can be developed using toxicological and epidemiological studies. It is not expected that toxicity values will be developed. A technical memorandum will be submitted to EPA and the State of Colorado for their review and approval listing the studies utilized to perform the toxicity assessment as required by the IAG Section VII.D.1.c. This memorandum will be submitted prior to the required submittal of the baseline risk assessment.

In addition to identifying appropriate toxicity values, this section of the Human Health Risk Assessment will provide brief toxicity profiles based on recent, published literature for each contaminant evaluated in the Human Health Risk Assessment. These profiles will describe the acute, chronic, and carcinogenic health effects associated with site-related contaminants identified in OU13. Acute and chronic exposure to site-related radionuclides will be discussed, but most



of the information presented will deal with the carcinogenic hazard posed by the site-specific radionuclides.

The toxicity assessment section will include a discussion of uncertainties. The numbers and kinds of uncertainties identified for the toxicity assessment directly impact the risk assessment. Uncertainties for the toxicity assessment are associated with the toxicity values and their derivation, or the lack of toxicity values for site-related contaminants. These could include, but may be limited to, the following:

- Not all constituents at the site have critical toxicity values (such as cancer slope factors or reference doses);
- Using cancer slope factors derived from the upper 95th percent confidence limit is likely to lead to overestimation of risk. Carcinogen slope factors assume no threshold for effect; if thresholds do exist, the true risks could be zero at sufficiently low doses;
- Lacking toxicity data, synergistic or antagonistic effects cannot be accounted for quantitatively; and
- Critical toxicity values derivation include, but may not be limited to, the following
  - Extrapolating toxicity values from high experimental doses to low doses for environmental exposures;
  - Extrapolating data from tests with experimental animals to humans; extrapolating test data collected over short durations to long-term exposure durations;
  - Extrapolating data collected using homogeneous experimental animal populations to humans who individually can vary substantially in their individual dose-response reactions;

- Extrapolating from continuous experimental doses given to animals to intermittent human exposure; and
- Extrapolating absorption rates.

The methods used to derive slope factors and reference doses are intended to be conservative in recognizing these types of uncertainties. In addition to the numerical approaches used to incorporate uncertainty in deriving toxicity values, the overall quality of the toxicology data base for a compound is evaluated. This can include consideration of a number of studies, their consistency, the availability of information on multiple species and multiple routes of administration, the demonstration of a clear dose-response relationship, plausible biological mechanisms of action, and especially direct evidence of effects in humans. Such reviews are performed by the EPA in developing toxicity parameter values and result in an overall evaluation of the confidence level in the toxicity values. Not all toxicity values represent the same degree of uncertainty; all are subject to change as new evidence becomes available.

## 8.5 RISK CHARACTERIZATION

This part of the Human Health Risk Assessment presents the evaluation of potential risks to public health associated with exposure to contaminants at the OU13 site. Potential carcinogenic and noncarcinogen risks associated with complete exposure pathways will be estimated. Risk characterization involves integrating exposure assumptions and toxicity information to quantitatively estimate the risk of adverse health effects. Risk characterization will be performed in accordance with EPA guidance (EPA, 1989c).

Noncancer risk will be assessed by comparing the estimated daily intake or exposure to a contaminant to its reference dose (RfD). This comparison measures the potential for noncarcinogenic health effects given the chemical intake factors used to estimate exposure. To

assess the potential for noncancer effects posed by multiple contaminants, the EPA's hazard index approach will be used. The method assumes dose additivity. Hazard quotients (individual chemical intake divided by the chemical RfD) are summed based on identification of target-tissues and like impacts to provide a hazard index; if the index exceeds one, there is a potential for health risk. This potential may be further examined by segregating the Hazard Quotients based on target organ and mechanism of action.

The potential for carcinogenic effect for nonradiological contaminants will be estimated by calculating excess lifetime cancer risks from the lifetime average exposure and cancer slope factor. IRIS slope factors for radionuclides of concern will be used to estimate radiological risks from exposure for up to four pathways: inhalation, ingestion, air immersion, and external irradiations. Calculations will be performed according to guidance provided by the EPA (1989c). The sum of risks from all radionuclides and pathways yields the lifetime risk from the overall exposure. Risks will be combined as appropriate, taking into consideration the plausibility of multiple exposures.

The Human Health Risk Assessment will present the chemical and radiological risk estimates separately with discussion on the additivity potential for these risks.

Both noncancer and cancer risks will be estimated by using RMinE and RMaxE combined with exposure assumptions. This allows risk ranges to be considered rather than a single value, and more closely considers the uncertainty associated with the estimates. In addition, risks may be added across exposure routes if conditions for doing so (i.e., biologically plausible and consistent with reasonably expected exposure scenarios) indicate that it is appropriate.

Not all contaminants identified at OU13 will have toxicity values, thereby limiting the ability to develop quantitative estimates of risk. Where adequate toxicity values cannot be identified, potential risks associated with exposure to those constituents will be dealt with qualitatively.

## 8.6 UNCERTAINTIES, LIMITATIONS, AND ASSUMPTIONS

The numbers and kinds of uncertainties identified in the Human Health Risk Assessment directly impact the interpretation of estimated risks developed in this section. Quantitative risk estimates derived in risk assessments are conditional estimates that include numerous assumptions about exposures and toxicity. Uncertainty is introduced from a variety of sources including, but not limited to, the following:

- Sampling and analysis;
- Exposure estimation;
- Exposure population dynamics; and
- Toxicological data.

Risk assessment involves extrapolation of often incomplete data and information obtained under one set of conditions to a likelihood or probability of events to be encountered under different circumstances. The objective of this task will be to evaluate the reliability of the Human Health Baseline Risk Assessment as a scientifically credible instrument upon which to base risk management decisions. An uncertainty analysis will be performed to characterize and quantify, to the extent practicable, the sources and magnitudes of uncertainty in the human health risk assessment. The existing data bases may be inadequate for accurate analysis, and the complexity of the process requires the incorporation of expert or subjective judgments. Quantitative techniques may include sensitivity analysis of testable or untestable assumptions, first-order

analysis to evaluate the propagation of errors, or numerical methods such as Monte Carlo analysis. Other methods of analysis of incomplete data sets may utilize Batesian theorems, expert systems that analyze the consequences of events relative to others, or other types of logic systems such as event or fault trees to handle uncertainty. The results of these analyses can be converted into quantitative terms to express probabilities.

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10/9/92  
Date

## 9.0 ENVIRONMENTAL EVALUATION

### 9.1 INTRODUCTION

OU13 lies predominantly within the production area at the RFP site. However, the eastern boundaries of OU13 provide a potential contaminant migration corridor between the production area and surrounding buffer zone. The zone within the production area has been developed to such an extent that there are little if any viable ecosystems or natural habitats presently existing. There are insufficient ecosystems, components, or functions existing on OU13 to require a comprehensive ecological risk assessment. The eastern portion of OU13 which allows potential biotic migration of contaminants into the buffer zone is overlapped with other plant site OUs, and is contained substantially within the OU9 preliminary study area. OU9, the Original Process Waste Lines network that extends throughout much of the production area, will address all habitat description necessary within the industrial area. The OU9 Environmental Evaluation (EE) Work Plan defines an ecological risk assessment within the production study area that is reduced in scope and focused on requirements proportional to the depauperate ecosystems considered. The objective of the OU13 EE is to determine if there is a risk of contamination to offsite biota through migration of contaminants offsite via biotic vectors.

Areas of concern in OU13 which bridge the boundary between the RFP site buffer zone and the production area are fully incorporated within OU6. These sections of OU13 are the portions of South Walnut Creek south of the STP (Sewage Treatment Plant) and just upstream of the B-

series ponds. Coordination of OU13 EE requirements with the OU9 and OU6 Environmental Evaluations is mandated by the overlapping study areas. Habitat and biological surveys proposed for OU9 and OU6 will cover the entire OU13 study area, and the results will apply to OU13. Following is a brief description of the study components presently proposed for OU9 and OU6, and how these studies will relate to OU13. These sections are based on a preliminary draft of a technical memorandum for revising the OU9 EEWP (EG&G, 1992).

## 9.2 BIOLOGICAL AND HABITAT SITE CHARACTERIZATION

Biota and habitat surveys proposed for OU9 and OU6 will be adequate for the biological and habitat characterization of OU13 and will not be duplicated or repeated. These surveys will provide the following information applicable to OU13:

- Comprehensive survey and mapping of types and extent of habitats, particularly habitats that could support species of special concern such as migratory birds;
- Presence and/or use of habitats of raptors and migratory birds, including waterfowl and passerine species;
- Presence or absence of threatened and endangered species, or species of special concern; and
- Data on small mammals or bird population dynamics, if present.

This characterization will include a literature review, expert consultation, and field surveys for vegetation, species of special concern, small mammals, and birds. Soil series will not be mapped because of the heavily disturbed nature of the soil surface within OU13. This information, will be included in the three following reports:

- Habitat survey report for compliance with acts for protection of migratory birds;

- Biological survey report for compliance with acts protecting species of special concern; and
- A technical memorandum reporting results of small mammals and bird surveys.

### 9.3 ECOTOXICOLOGICAL INVESTIGATIONS

Ecotoxicological investigations will be conducted if the following conditions are present on OU13:

- If target taxa are present on the study area and are shown, by preliminary tissue analysis, to be accumulating or concentrating target analytes; and either
- The contaminated target taxa are capable of migration outside the OU13 study boundaries; or
- The contaminated target taxa are highly mobile and actually move outside the study or industrial area boundaries.

If the above conditions are not met, then it is presumed that there is no risk of contamination of offsite biota from OU13.

If an ecotoxicological investigation is necessary, it would consist of the following procedures:

- Developing a site-specific Conceptual Exposure Model to identify potential pathways for exposure of onsite biota;
- Developing a Conceptual Biota Transport model to identify potential pathways for offsite transport;
- Selection of target taxa and target analytes (biologically active COCs); and
- Direct measurement of target analytes within target taxa.



The procedures for conducting this type of investigation for the industrial area are presently under development for OU9. Results from the OU9 ecotoxicological investigations would be utilized for OU13. No separate site-specific ecotoxicological investigations are planned. Procedures and results from the OU6 EE would be used as needed for investigation of the eastern portion of OU13 incorporating habitat in and around South Walnut Creek, upstream of the B-series ponds.

This information would be used to assess the ecological risk posed by contaminant migration by contaminated target taxa. Information on contaminant migration by target taxa to other OUs will be provided to those OU managers for use in conducting their EEs for identifying ecological risks. This would be a quantitative estimate with the appropriate uncertainty analysis for model assumptions and estimates of parameters. This information would also be coordinated with contaminant migration by physical or abiotic media developed during the site characterization and transport models.

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## 10.0 QUALITY ASSURANCE ADDENDUM

This section consists of the Quality Assurance Addendum (QAA) for Phase I investigations at Operable Unit No. 13 (OU13), which supplements the "Rocky Flats Plant Site-Wide Quality Assurance Project Plan for CERCLA Remedial Investigation/Feasibility Studies and RCRA Facility Investigations/Corrective Measures Studies Activities" (QAPjP). This QAA establishes the site-specific Quality Assurance (QA) controls applicable to the investigation activities described in the OU13 Work Plan (OU13 WP).

OU13 is one of 16 operable units (OUs) identified for investigations under the Rocky Flats Plant (RFP) Interagency Agreement (IAG). OU13 contains 15 individual hazardous substance sites (IHSSs), which are described in Section 2.1 of the OU13 WP. Section 2.2 describes the nature and extent of contamination at the IHSSs within OU13. The OU13 WP was prepared in accordance with EPA/530/SW-89-031, "RCRA Facility Investigation (RFI) Guidance" (May 1989), EPA/540/8-89/004, "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" (October 1988), and the IAG.

### 10.1 ORGANIZATION AND RESPONSIBILITIES

The overall organization of EG&G Rocky Flats and the Environmental Management Department (EMD) and divisions involved in Environmental Restoration (ER) Program activities is shown

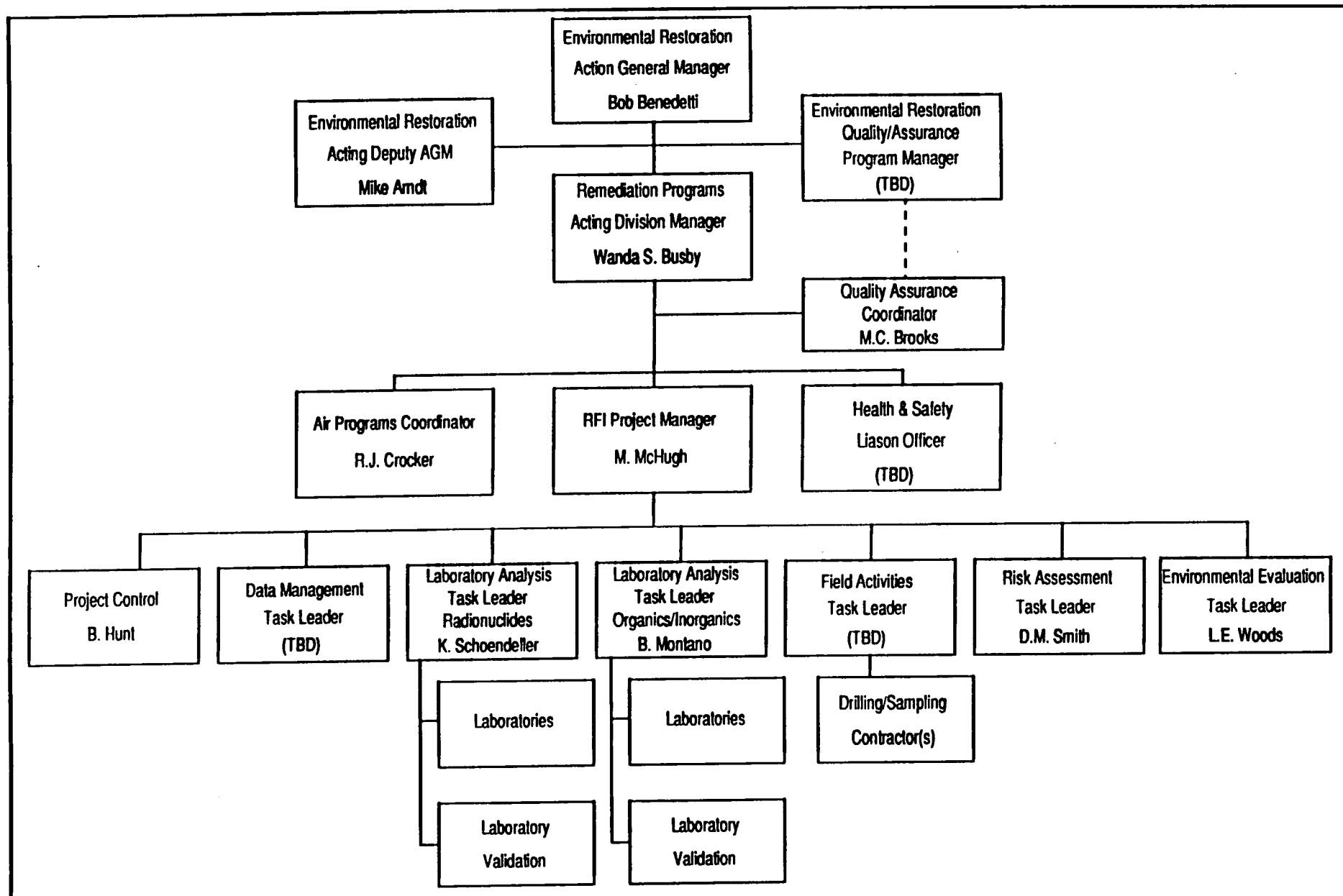
in Figures 1-1, 1-2, and 1-3 of Section 1.0 of the QAPjP. Individual responsibilities are also described in Section 1.0 of the (QAPjP).

Contractors will be tasked by EG&G Rocky Flats to implement the field activities outlined in the OU13 WP. The specific EMD personnel who will interface with the Contractors and who will provide technical direction are shown in Figure 10-1.

## 10.2 QUALITY ASSURANCE PROGRAM

The QAPjP was written to address QA controls and requirements for implementing IAG-related activities. The content of the QAPjP was driven by Department of Energy (DOE) RFP Standard Operating Procedure (SOP) 5700.6B, which requires a QA program to be implemented for all RFP activities based on American Society of Mechanical Engineers (ASME) NQA-1, "Quality Assurance Requirements for Nuclear Facilities," as well as the IAG, which specifies that a QAPjP for IAG related activities be developed in accordance with EPA/QAMS-005/80, "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans." The 18-element format of NQA-1 was selected as the basis for both the QAPjP and subsequent QAAs with the applicable elements of QAMS-005/80 incorporated where appropriate. Figure 2-1 of the QAPjP illustrates where the 16 QA elements of QAMS-005/80 are integrated into the QAPjP and also into this QAA. Section 2.0 of the QAPjP also identifies other DOE Orders and QA requirements documents to which the QAPjP and this QAA are responsive.

The controls and requirements addressed in the QAPjP are applicable to OU13 Phase I activities, unless specified otherwise in this QAA. Where site-wide actions are applicable to OU13 activities, the applicable section of the QAPjP is referenced in this QAA. This QAA addresses additional and site-specific QA controls and requirements that are applicable to OU13 Phase I RFI/RI activities that may not have been addressed on a site-wide basis in the QAPjP. Many of



**FIGURE 10-1**  
**PROJECT MANAGEMENT FOR OPERABLE UNIT NO. 13**

OPERABLE UNIT NO. 13  
PHASE I RFV/RI WORK PLAN  
U.S. DEPARTMENT OF ENERGY  
Rocky Flats Plant, Golden, Colorado

the QA requirements specific to OU13 are addressed within other sections of this work plan and are referenced in this QAA.

#### 10.2.1 Training

Personnel qualification and training requirements for RFP ER Program activities are addressed in Section 2.0 of the QAPjP. Personnel qualifications and training required to perform the EMD Operating Procedures (OPS) that are applicable to OU13 investigations are specified within the respective procedures. The EMD OPS (which may also be referred to as EM Standard Operating Procedures [SOPs] in the QAPjP and the OU13 WP) that are applicable to Phase I activities at OU13 are identified in Table 10.1.

#### 10.2.2 Quality Assurance Reports to Management

A QA summary report will be prepared annually or at the conclusion of these activities (whichever is more frequent) by the EMD Quality Assurance Project Manager (QAPM) or designee. This report will include a summary of field operation and laboratory inspections, surveillance, and audits and a report on data verification/validation results.

### 10.3 DESIGN CONTROL AND CONTROL OF SCIENTIFIC INVESTIGATIONS

#### 10.3.1 Design Control

The OU13 WP describes the investigation activities that will be implemented during the Phase I characterization of the OU13 IHSSs. The work plan identifies the objectives of the investigations; specifies the sampling, analysis, and data generation requirements; and identifies

**TABLE 10.1**  
ER Operating Procedures and Field Activities  
for Which They are Applicable

EMAD OPS

Reference  
Numbers

Standard Operating Procedures

		Field Radiation Surveys	Well Drilling Completion, Development	Ground-Water Sampling	Soil Gas Surveys	Surface Soil and Soil Scrape Sampling	Subsurface Soil Sampling
FO.01	Wind Blown Contaminant Dispersion Control					●	
FO.02	Field Document Control	●	●	●	●	●	●
FO.03	General Equipment Decontamination	●	●	●	●	●	●
FO.04	Heavy Equipment Decontamination		●	●		●	●
FO.05	Handling of Purge and Development Water		●	●			
FO.06	Handling of Personal Protective Equipment	●	●	●	●	●	●
FO.07	Handling of Decontamination Water & Wash Water	●	●	●	●	●	●
FO.08	Handling of Drilling Fluids & Cuttings		●				●
FO.09	Handling of Residual Samples					●	●
FO.10	Receiving, Labeling, and Handling Waste Containers		●	●			●
FO.11	Field Communications	●	●	●	●	●	●
FO.12	Decontamination Facility Operations	●	●	●	●	●	●
FO.13	Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples			●	●	●	●
FO.14	Field Data Management	●	●	●	●	●	●
FO.15	Use of PIDS and FIDS		X	X	X	X	X
FO.16	Field Radiological Measurements a) Walk-Over Surveys	●	X	X	X	X	X
FO.18	Environmental Sample Radioactivity Content Screening			●		●	●
GW.01	Water Level Measurements in Wells and Piezometers		●	●			
GW.02	Well Development		●				
GW.03	Measurements for Groundwater Field Parameters			●			
GW.04	Groundwater Sampling			●			

X-As required by H&S plan.

TABLE 10.1 (Continued)  
ER Operating Procedures and Field Activities  
for Which They are Applicable

EMAD OPS Reference Numbers	Standard Operating Procedures							
		Field Radiation Surveys	Well Drilling Completion, Development	Ground-Water Sampling	Soil Gas Surveys	Surface Soil and Soil Scrape Sampling	Subsurface Soil Sampling	
GT.01	Logging Alluvial and Bedrock Material		●				●	
GT.02	Drilling and Sampling Using Hollow-Stem Auger Tech.		●				●	
GT.03	Isolating Bedrock from the Alluvium with Surface Casing		●				●	
GT.05	Plugging and Abandonment of Boreholes		●				●	
GT.06	Monitoring Well and Piezometer Installation		●					
GT.08	Surface Soil Sampling					●		
GT.09	Soil Gas Sampling and Field Analysis							
GT.10	Borehole Clearing		●				●	
GT.15	Geophysical Borehole Logging		●				●	
GT.17	Land Surveying		●				●	
GT.19	Field Gas Chromatographs				●			
GT.22	BAT In-Situ Sampler (Proposed)			●				
EMAD OPS Reference Numbers								
1.1	Gamma Radiation Surveys	●						
1.2	Beta Radiation Surveys	●						
3.2	Survey Requirements for Conditional & Unrestricted Use	●						

applicable operating procedures that will provide controls for the investigations. As such, the OU13 WP is considered the investigation control plan for the OU13 Phase I RFI/RI activities.

### 10.3.2 Data Quality Objectives

The development of Data Quality Objectives (DQOs) for the OU13 Phase I investigations was presented in Section 5.0. The DQOs for OU13 were established in accordance with 3-stage process described in EPA OSWER Directive 9355.0-7B, Data Quality Objectives for Remedial Response Activities, and Appendix A of the QAPjP.

Identification of data quality needs includes defining investigation objectives and identifying data uses and the types of data that need to be collected. Specific Phase 1 investigation objectives, data uses, data types, and data quality objectives (DQOs) for OU13 were defined in Section 5.0. Other factors that are necessary in identifying data quality needs include selecting appropriate analytical levels, contaminants of concern, levels of concern, required detection limits, and critical samples. The identification and selection of these factors were also established in Section 5.0.

Data quality is typically measured in terms of precision, accuracy, representativeness, comparability, and completeness (also referred to as PARCC parameters). Precision, accuracy, and completeness are quantitative measures of data quality, while representativeness and comparability are qualitative statements that express the degree to which sample data represent actual conditions and describe the confidence of one data set to another. These parameters are defined in Appendix A of the QAPjP. PARCC parameters will be determined for OU13 Phase I measurement data, as described previously in Section 5.0. PARCC parameter goals, that are established prior to initiating investigations, assist decision makers to determine if DQOs for measurement data have been met.



The specific goals for precision and accuracy for the potential contaminants present that were identified in Table 5.3 are presented in Table 10.2. The goals for precision and accuracy presented in Table 10.2 are based primarily on historical measures of precision and accuracy for the specified methods of analysis. The specific methods of analysis were selected based on the analytical level of measurement data established in Section 5.0. The goal for completeness is 100 percent with a minimum acceptable completeness of 90 percent for laboratory measurement data and 80 percent for field measurements.

Based on the data quality needs identified for OU13 Phase I investigations, the sampling and analytical options were evaluated. The sampling and analytical methods selected for OU 13 Phase I investigations are listed in Tables 5.4 and 6.1. The specific field analytical methods and the Standard EPA and EPA CLP laboratory methods are identified in Table 10.2.

#### 10.3.3 Sampling Locations and Sampling Procedures

The sampling plan for OU13 was described in Section 6.0. Sampling activities will be staged, with the initial stages providing information that will be used to direct and refine sampling methods and sampling locations in subsequent stages. The rationale for this stage approached was presented in Section 6.1. The field sampling plan for OU13 was summarized in Table 6.1.

The operating procedures that are applicable to OU13 Phase I field activities and the particular activities to which they are applicable were listed in Tables 6.1 and 10.1.

#### 10.3.4 Analytical Procedures

The analytical requirements for the OU13 Phase I RFI/RI was discussed in Section 6.3. The analytes of interest and the specified detection limits for radiation surveys, surface scrape

**TABLE 10.2**  
**ANALYTICAL METHODS, DETECTION LIMITS, AND DATA QUALITY OBJECTIVES**

Analyte	Method	GW	SOIL	Required Detection Limits		Precision Objective	Accuracy Objective
				Water	Soil		
INDICATORS							
Total Organic Carbon	EPA 415 <sup>d</sup> ASTM D4129-82	X <sup>U</sup>	X	5 mg/l		20%RPD <sup>e</sup>	80-120% LCS Recovery
INORGANICS							
Target Analyte List - Metals		X <sup>P</sup>	X			WATER/SOIL	WATER/SOIL
Aluminum	EPA CLP SOW <sup>a</sup>			200 ug/L <sup>4</sup>	40 mg/Kg <sup>4</sup>	**	**
Antimony	EPA CLP SOW <sup>a</sup>			60	12		
Arsenic (GFAA)	EPA CLP SOW <sup>a</sup>			10	2		
Barium	EPA CLP SOW <sup>a</sup>			200	40		
Beryllium	EPA CLP SOW <sup>a</sup>			5	1		
Cadmium	EPA CLP SOW <sup>a</sup>			5	1		
Calcium	EPA CLP SOW <sup>a</sup>			5000	2000		
Chromium	EPA CLP SOW <sup>a</sup>			10	2		
Cobalt	EPA CLP SOW <sup>a</sup>			50	10		
Copper	EPA CLP SOW <sup>a</sup>			25	5		
Cyanide	EPA 335.3	(modified for CLP) <sup>a,d</sup>		5	10		
Iron	EPA CLP SOW <sup>a</sup>			100	20		
Lead (GFAA)	EPA CLP SOW <sup>a</sup>			3	1		
Magnesium	EPA CLP SOW <sup>a</sup>			5000	2000		
Manganese	EPA CLP SOW <sup>a</sup>			15	3		
Mercury (CVAA)	EPA CLP SOW <sup>a</sup>			0.2	.2		
Nickel	EPA CLP SOW <sup>a</sup>			40	8		
Potassium	EPA CLP SOW <sup>a</sup>			5000	2000		
Selenium (GFAA)	EPA CLP SOW <sup>a</sup>			5	1		
Silver	EPA CLP SOW <sup>a</sup>			10	2		
Sodium	EPA CLP SOW <sup>a</sup>			5000	2000		
Thallium (GFAA)	EPA CLP SOW <sup>a</sup>			10	2		
Vanadium	EPA CLP SOW <sup>a</sup>			50	10		
Zinc	EPA CLP SOW <sup>a</sup>			20	4		

Analyte	Method	GW	SOIL	Required Detection Limits		Precision Objective	Accuracy Objective
				Water	Soil		
ANIONS							
Sulfate	EPA 375.4 <sup>d</sup>		X	1	mg/L	Water/Soil	Water/Soil
Nitrate	EPA 353.2 <sup>d</sup> or 353.3 <sup>d</sup>	X <sup>U</sup>	X			Same as Metals	Same as Metals
Fluoride	(TBD)		X				
Target Compound List - Volatiles		X <sup>U</sup>	X			WATER/SOIL	WATER/SOIL
Chloromethane	EPA CLP SOW <sup>c</sup>				10 ug/L	10 ug/Kg (low) <sup>3</sup>	**
Bromomethane	EPA CLP SOW <sup>c</sup>				10	10	
Vinyl Chloride chloroethane	EPA CLP SOW <sup>c</sup>				10	10	
Methylene Chloride	EPA CLP SOW <sup>c</sup>				10	10	
Acetone	EPA CLP SOW <sup>c</sup>				5	5	
Carbon Disulfide	EPA CLP SOW <sup>c</sup>				10	10	
1,1-Dichloroethene	EPA CLP SOW <sup>c</sup>				5	5	
1,1-Dichloroethane	EPA CLP SOW <sup>c</sup>				5	5	
total 1,2-Dichloroethene	EPA CLP SOW <sup>c</sup>				5	5	
Chloroform	EPA CLP SOW <sup>c</sup>				5	5	
1,2-Dichloroethane	EPA CLP SOW <sup>c</sup>				5	5	
2-Butanone	EPA CLP SOW <sup>c</sup>				1	1	
1,1,1-Trichloroethane	EPA CLP SOW <sup>c</sup>				10	10	
Carbon Tetrachloride	EPA CLP SOW <sup>c</sup>				5	5	
Vinyl Acetate	EPA CLP SOW <sup>c</sup>				5	5	
Bromodichloromethane	EPA CLP SOW <sup>c</sup>				10	10	
1,2-Dichloropropane	EPA CLP SOW <sup>c</sup>				5	5	
cis-1,3-Dichloropropene	EPA CLP SOW <sup>c</sup>				5	5	
Trichloroethane	EPA CLP SOW <sup>c</sup>				5	5	
Dibromochloromethane	EPA CLP SOW <sup>c</sup>				5	5	
1,1,2-Trichloroethane	EPA CLP SOW <sup>c</sup>				5	5	
Benzene	EPA CLP SOW <sup>c</sup>				5	5	
trans-1,2-Dichloropropene	EPA CLP SOW <sup>c</sup>				5	5	
Bromoform	EPA CLP SOW <sup>c</sup>				5	5	
4-Methyl-2-pentanone	EPA CLP SOW <sup>c</sup>				5	5	
2-Hexanone	EPA CLP SOW <sup>c</sup>				10	10	
Tetrachloroethene	EPA CLP SOW <sup>c</sup>				10	10	
Toluene	EPA CLP SOW <sup>c</sup>				5	5	
1,1,2,2-Tetrachloroethane	EPA CLP SOW <sup>c</sup>				5	5	
Chlorobenzene	EPA CLP SOW <sup>c</sup>				5	5	
Ethyl Benzene	EPA CLP SOW <sup>c</sup>				5	5	
Styrene	EPA CLP SOW <sup>c</sup>				5	5	
Total Xylenes	EPA CLP SOW <sup>c</sup>				5	5	

10.2  
ANALYTICAL METHODS, DETECTION LIMITS, AND DATA QUALITY OBJECTIVES

Analyte	Method	Required Detection Limits				Precision Objective	Accuracy Objective
		GW	SOIL	Water	Soil		
Target Compound List - Semi-Volatiles			X			SOIL	SOIL
Phenol	EPA CLP SOW <sup>c</sup>				330 ug/Kg <sup>1</sup>	**	***
bis(2-Chloroethyl)ether	EPA CLP SOW <sup>c</sup>				330		
2-Chlorophenol	EPA CLP SOW <sup>c</sup>				330		
1,3-Dichlorobenzene	EPA CLP SOW <sup>c</sup>				330		
1,4-Dichlorobenzene	EPA CLP SOW <sup>c</sup>				330		
Benzyl Alcohol	EPA CLP SOW <sup>c</sup>				330		
1,2-Dichlorobenzene	EPA CLP SOW <sup>c</sup>				330		
2-Methylphenol	EPA CLP SOW <sup>c</sup>				330		
bis(2-Chloroisopropyl)ether	EPA CLP SOW <sup>c</sup>				330		
4-Methylphenol	EPA CLP SOW <sup>c</sup>				330		
N-Nitroso-Dipropylamine	EPA CLP SOW <sup>c</sup>				330		
Hexachloroethane	EPA CLP SOW <sup>c</sup>				330		
Nitrobenzene	EPA CLP SOW <sup>c</sup>				330		
Isophorone	EPA CLP SOW <sup>c</sup>				330		
2-Nitrophenol	EPA CLP SOW <sup>c</sup>				330		
2,4-Dimethylphenol	EPA CLP SOW <sup>c</sup>				330		
Benzoic Acid	EPA CLP SOW <sup>c</sup>				1600		
bis(2-Chloroethoxy)methane	EPA CLP SOW <sup>c</sup>				330		
2,4-Dichlorophenol	EPA CLP SOW <sup>c</sup>				330		
1,2,4-Trichlorobenzene	EPA CLP SOW <sup>c</sup>				330		
Naphthalene	EPA CLP SOW <sup>c</sup>				330		
4-Chloroaniline	EPA CLP SOW <sup>c</sup>				330		
Hexachlorobutadiene	EPA CLP SOW <sup>c</sup>				330		
4-Chloro-3-methylphenol	EPA CLP SOW <sup>c</sup>				330		
2-Methylnaphthalene	EPA CLP SOW <sup>c</sup>				330		
Hexachlorocyclopentadiene	EPA CLP SOW <sup>c</sup>				330		
2,4,6-Trichlorophenol	EPA CLP SOW <sup>c</sup>				330		
2,4,5-Trichlorophenol	EPA CLP SOW <sup>c</sup>				1600 ug/Kg <sup>1</sup>		
2-Chloronaphthalene	EPA CLP SOW <sup>c</sup>				330		
2-Nitroaniline	EPA CLP SOW <sup>c</sup>				1600		
Dimethylphthalate	EPA CLP SOW <sup>c</sup>				330		
Acenaphthylene	EPA CLP SOW <sup>c</sup>				330		
2,6-Dinitrotoluene	EPA CLP SOW <sup>c</sup>				330		
3-Nitroaniline	EPA CLP SOW <sup>c</sup>				1600		
Acenaphthene	EPA CLP SOW <sup>c</sup>				330		
2,4-Dinitrophenol	EPA CLP SOW <sup>c</sup>				1600		

Required Detection Limits							
Analyte	Method	GW	SOIL	Water	Soil	Precision Objective	Accuracy Objective
Target Compound List - Semi-Volatiles (con't.)						Water/Soil	Water/Soil
4-Nitrophenol	EPA CLP SOW <sup>c</sup>				1600 ug/Kg <sup>3</sup>	**	***
Dibenzofuran	EPA CLP SOW <sup>c</sup>				330		
2,4-Dinitrotoluene	EPA CLP SOW <sup>c</sup>				330		
Diethylphthalate	EPA CLP SOW <sup>c</sup>				330		
4-Chlorophenol Phenyl ether	EPA CLP SOW <sup>c</sup>				330		
Fluorene	EPA CLP SOW <sup>c</sup>				330		
4-Nitroaniline	EPA CLP SOW <sup>c</sup>				1600 ug/Kg <sup>3</sup>		
4,6-Dinitro-2-methylphenol	EPA CLP SOW <sup>c</sup>				1600		
N-nitrosodiphenylamine	EPA CLP SOW <sup>c</sup>				330		
4-Bromophenyl Phenyl ether	EPA CLP SOW <sup>c</sup>				330		
Hexachlorobenzene	EPA CLP SOW <sup>c</sup>				330		
Pentachlorophenol	EPA CLP SOW <sup>c</sup>				1600		
Phenanthrene	EPA CLP SOW <sup>c</sup>				330		
Antracene	EPA CLP SOW <sup>c</sup>				330		
Di-n-butylphthalate	EPA CLP SOW <sup>c</sup>				330		
Fluoranthene	EPA CLP SOW <sup>c</sup>				330		
Pyrene	EPA CLP SOW <sup>c</sup>				330		
Butyl Benzylphthalate	EPA CLP SOW <sup>c</sup>				330		
3,3'-Dichlorobenzidine	EPA CLP SOW <sup>c</sup>				660		
Benzo(a)anthracene	EPA CLP SOW <sup>c</sup>				330		
Chrysene	EPA CLP SOW <sup>c</sup>				330		
bis(2-ethylhexyl)phthalate	EPA CLP SOW <sup>c</sup>				330		
Di-n-octyl Phthalate	EPA CLP SOW <sup>c</sup>				330		
Benzo(b)fluoranthene	EPA CLP SOW <sup>c</sup>				330		
Benzo(k)fluoranthene	EPA CLP SOW <sup>c</sup>				330		
Benzo(a)pyrene	EPA CLP SOW <sup>c</sup>				330 ug/Kg <sup>3</sup>		
Indeno(1,2,3-cd)pyrene	EPA CLP SOW <sup>c</sup>				330		
Dibenz(a,h)anthracene	EPA CLP SOW <sup>c</sup>				330		
Benzo(g,h,i)perylene	EPA CLP SOW <sup>c</sup>				330		
RADIONUCLIDES						(Replicate Analyses)	(Laboratory Control Sample)

Analyte	Method	GW	SOIL	Required Detection Limits		Precision Objective	Accuracy Objective
				Water	Soil		
Gross Alpha	s,f,g,h,i,k,l,m,n		X	NA	4	pCi/g	**
Gross Beta	s,f,g,h,i,k,l,m,n		X	NA	10	pCi/g	***
Uranium	f,h,i,m,n,s,l	X <sup>F</sup>	X	0.6	pCi/L .03	pCi/g	
233+234							
Uranium 235, 238	f,h,i,m,n,s,l		X	NA	.03	pCi/g	
Americium 241	p,q,s,l,i		X	NA	0.02	pCi/g	
Plutonium 239+240	o,p,s,l,i	X <sup>F</sup>	X	0.01	pCi/L 0.03	pCi/g	
Tritium	f,g,h,m,s,i,l	X <sup>U</sup>	X	400	pCi/L 400	pCi/L	
Strontium 89,90	f,h,i,m,s,l		X	NA	1	pCi/g	

Analyte	Method	GW	SOIL	Required Detection Limits		Precision Objective	Accuracy Objective
				Water	Soil		
FIELD PARAMETERS				Detection Limit	Precision	Accuracy	
1,1,1-Trichloroethane	EPA 502.2		X	5 ug/L	35% RPD		
Carbon tetrachloride	EPA 502.2		X	5 ug/L	35%		
Methylethylketone	EPA 502.2		X	10 ug/L	35%		
Dichloromethane	EPA 502.2		X	5 ug/L	35%		
Perchloroethene	EPA 502.2		X	5 ug/L	35%		
Trichloroethene	EPA 502.2		X	5 ug/L	35%		
Benzene	EPA 502.2		X	5 ug/L			
Toluene	EPA 502.2		X	5 ug/L			
Xylene	EPA 502.2		X	5 ug/L			
pH	1		X	+0.1 pH unit	NA		+0.2 pH units
Specific conductance	1		X	25 umho/cm <sup>1</sup>	NA		+2.5% max. error at 500, 5000, 50000 umhos/cm plus probe;
				25 umho/cm <sup>1</sup>			
				250 umho/cm <sup>1</sup>	NA		+ 3.0% max. error at 250, 2500, and 25000 plus probe accuracy of + 2.0%.
Temperature	1		X	± 0.1°C	NA		±1.0°C
Bata/Gamma	Geiger Muller Detector		X	5,000 dpm/100cm <sup>2</sup> ±20% error		NA	
Alpha Radiation	FIDLER		X	300 dpm/100cm <sup>2</sup> ±20% error		NA	

\*\* Precision objective = control limits specified in referenced method and/or Data Validation Guidelines.

\*\*\* Accuracy objective = control limits specified in referenced method (in GRRASP for radionuclides).

F = Filtered

U = Unfiltered

1. Measured in the field in accordance with instrument manufacturer's instructions. The instruments to be used are specified in Section 12.
2. Medium soil/sediment required detection limits for pesticide/PCB TCL compounds are 15 times the individual low soil/sediment required detection limit.
3. Detection limits listed for soil/sediment are based on wet weight. The detection limits calculated by the laboratory for soil/sediment, calculated on dry weight basis as required by the contract, will be higher.
4. Higher detection limits may only be used in the following circumstances: If the sample concentration exceeds five times the detection limit of the instrument or method in use, the value may be reported even though the instrument or method detection limit may not equal the required detection limit.

This is illustrated in the example below:

For lead:

Method in use - ICP

Instrument Detection Limit (IDL) - 40

Sample Concentration - 220

Required Detection Limit (RDL) - 3

The value of 220 may be reported even though the instrument detection limit is greater than the RDL.

Note: The specified detection limits are based on a pure water matrix. The detection limits for samples may be considerably higher depending on the sample matrix.

5. If gross alpha > 5 pCi/L, analyze for Radium 226; If Radium 226 > 3 pCi/L, analyze for Radium 228.
6. The detection limits presented were calculated using the formula in N.R.C. Regulatory Guide 4.14, Appendix Lower Limit of Detection, pg. 21, and follow:

$$\text{LLD} = \frac{4.66 (\text{BKG/BKG DUR})^{1/2}}{(2.22)(\text{Eff})(\text{CR})(\text{SR})(e^{-\lambda t})(\text{Aliq})} \quad \text{MDA} = \frac{4.66 (\text{BKG/Sample DUR})^{1/2}}{(2.22)(\text{Eff})(\text{CR})(\text{CR})(e^{-\lambda t})(\text{Aliq})}$$

Where:

LLD = Lower Limit of Detection in pCi per sample unit.

BKG = Instrument Background in counts per minute (CPM). BKG = Same as for LLD

Eff = Counting efficiency in cpm/disintegration per minute (dpm).

CR = Fractional radiochemical yield.

SR = Fractional radiochemical yield of a known solution

= The radioactive decay constant for the particular radionuclide

t = The elapsed time between sample collection and counting.

Aliq = Sample Volume.

BKG DUR = Background count duration in minutes.

MDA = Minimum Detectable Activity in pCi per sample unit

BKG = Same as for LLD

Eff = Same as for LLD

CR = Same as for LLD

SR = Same as for LLD

= Same as for LLD

= Same as for LLD

t = Same as for LLD

Aliq = same as for LLD

Sample DUR = sample count duration in minutes



7. On 500 umho/cm range.
8. On 5000 umho/cm range.
9. On 50000 umho/cm range.
- a. U.S. Environmental Protection Agency Contract Laboratory Program Statement of Work for Inorganics Analysis, Multi-Media, Multi-Concentration, 7/88 (or latest version).
- b. U.S. Environmental Protection Agency Contract Laboratory Program Statement of Work for Inorganics Analysis, Multi-Media, Multi-Concentration, 7/88 (or latest version). The specific method to be utilized is at the laboratory's discretion provided it meets the specified detection limit.
- c. U.S. Environmental Protection Agency Contract Laboratory Program Statement of Work for Inorganic Analysis, Multi-Media, Multi-Concentration, 2/88 (or latest version).
- d. Methods are from "Methods for Chemical Analysis of Water and Wastes," U.S. Environmental Protection Agency, 1983, unless otherwise indicated.
- e. Methods are from "Test Methods for Evaluation of Solid Waste, Physical/Chemical Methods," (SW-846, 3rd Ed.), U.S. Environmental Protection Agency.
- f. U.S. Environmental Protection Agency, 1979, Radiochemical Analytical Procedures for Analysis of Environmental Samples, Report No. EMSL-LY-0539-1, Las Vegas, NV, U.S. Environmental Protection Agency.
- g. American Public Health Association, American Water Works Association, Water Pollution Control Federation, 1985. Standard Methods for the Examination of Water and Wastewater, 16th ed., Washington, D.C., Am. Public Health Association.
- h. U.S. Environmental Protection Agency, 1976. Interim Radiochemical Methodology for Drinking Water, Report No. EPA-600/4-75-008. Cincinnati U.S. Environmental Protection Agency.
- i. Harley, J.H., ed., 1975, ASL Procedures Manual, HASL-300; Washington, D.C., U.S. Energy Research and Development Administration.
- j. U.S. EPA, 1982. "Methods for Organic Analysis of Municipal and Industrial Waste Water," U.S. EPA-600/4-82-057.
- k. "Handbook of Analytical Procedures," USAEC, Grand Junction Lab. 1970, page 196.
- l. "Prescribed Procedures for Measurement of Radioactivity in Drinking Water," EPA-600/4-80-032, August 1980, Environmental Monitoring and Support Laboratory, Office of Research and Development, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268.
- m. "Methods for Determination of Radioactive Substances in Water and Fluvial Sediments," U.S.G.S. Book 5, chapter A5, 1977.
- n. "Acid Dissolution Method for the Analysis of Plutonium in Soil," EPA-600/7-79-081, March 1979, U.S. EPA Environmental Monitoring and Support Laboratory, Las Vegas, Nevada, 1979.
- o. "Procedures for the Isolation of Alpha Spectrometrically Pure Plutonium, Uranium, and Americium," by E.H. Essington and B.J. Drennon, Los Alamos National Laboratory, a private communication.
- p. "Isolation of Americium from Urine Samples," Rocky Flats Plant, Health, Safety, and Environmental Laboratories.
- q. "Radioactivity in Drinking Water," EPA 570/9-81-002.
- r. If the sample or duplicate result is  $\leq$  x IDL, then the control limit is  $\pm$  IDL.
- s. U.S. EPA, 1987. "Eastern Environmental Radiation Facility Radiochemistry Procedures Manual," EPA-502/5-84-006.

radiochemistry, soil gas sampling, subsurface (borehole) soil sampling, shallow soil sampling, and alluvial groundwater sampling for each IHSS were identified in Tables 5.4 and 6.1. The analytical methods that shall be adhered to are those that are specified in the EG&G Rocky Flats General Radiochemistry and Routine Analytical Services Protocol (GRRASP), Parts A and B. These methods are referenced in Section 3.0 of the QAPjP. Specific analytical methods for each potential contaminant present identified in Table 5.3 are referenced in Tables 5.4 and 10.2.

#### 10.3.5 Equipment Decontamination

Non-dedicated sampling equipment (i.e., sampling equipment that is used at more than one location) shall be decontaminated between sampling locations in accordance with OPS-FO.03, General Equipment Decontamination. Other equipment (e.g., heavy equipment) potentially contaminated during drilling, boring, well installation, sample collection, etc. shall be decontaminated as specified in OPS-FO.04, Heavy Equipment Decontamination.

#### 10.3.6 Air Quality

Air monitoring will be conducted during implementation of field activities that have the potential to create windblown dispersion of contaminants, including drilling, coring, and installation of boreholes and monitoring wells. Air monitoring will ensure that OUI3 RFI/RI activities comply with the RFP Interim Plan for Prevention of Contaminant Dispersion. Air monitoring will be conducted according to OPS-FO.01, Wind Blown Contaminant Dispersion Control.

#### 10.3.7 Quality Control

To ensure the quality of the field sampling techniques, collection and/or preparation of field quality control (QC) samples are incorporated into the sampling scheme. Field QC samples and

collection frequencies for OU13 were addressed in Section 6.4 and are identified in Table 6.3. A specific sampling schedule will be prepared by the sampling subcontractor for approval by the EG&G Laboratory Analysis Task Leader (Figure 10-1) prior to sampling.

#### 10.3.7.1 Objectives for Field QC Samples

Equipment rinsate blanks are considered acceptable (with no need for data qualification) if the concentration of analytes of interest is less than three times the required detection limit for each analyte as specified in Table 4.4. Equipment rinsate blanks may only be analyzed if contaminants of concern are detected above background in samples. Field duplicate samples shall agree within 30 percent relative percent difference for aqueous samples and 40 percent for homogenous, non-aqueous samples.

Trip blanks and field preservation blanks (for organics and inorganics, respectively) indicate possible field contamination when analytes are detected above the minimum detection limits presented in Table 4.4. The Laboratory Analysis Task Leader is responsible for verifying these criteria and is also responsible for checking to see if they are met and for qualifying measurement data.

#### 10.3.7.2 Laboratory QC

Laboratory QC procedures are used to provide measures of internal consistency for analyses and storage of samples. The laboratory contractor will submit written SOPs to the Laboratory Analysis Task Leader for approval. The interlaboratory SOPs shall be consistent with or equivalent to EPA-CLP QC procedures. The laboratory SOPs must cover the following areas in sufficient detail and reflect actual operating conditions in effect during analysis of EG&G RFP samples:

- Sample receipt and log-in
- Sample storage and security
- Facility security
- Sample tracking (from receipt to sample disposition)
- Sample analysis method references
- Data reduction, verification, and reporting
- Document control (including submitting documents to EG&G)
- Data package assembly (see Section III.A of the GRRASP)
- Qualifications of personnel
- Preparation of standards
- Equipment maintenance and calibration
- List of instrumentation and equipment (including date purchased, date installed, model number, manufacturer, and service contracts, if any)
- Instrument detection limits
- Acceptance criteria for non-CLP analyses
- Laboratory QC checks applicable to each analytical method.

Laboratory QC techniques to ensure consistency and validity of analytical results (including detecting potential laboratory contamination of samples) include using reagent blanks, field blanks, internal standard reference materials, laboratory-replicate analysis, and field duplicates. The laboratory contractor will follow the standard evaluation guidelines and QC procedures, including frequency of QC checks, that are applicable to the particular type of analytical method

being used as specified in Parts A and B of the GRRASP and Section 3.0 of the QAPjP. All data packages will be forwarded to the Laboratory Analysis Task Leader or validation contractor for review and verification.

#### 10.3.8 Quality Assurance Monitoring

To assure the overall quality of the RFI/RI activities discussed in the OU13 WP, field inspections will be conducted daily and audits and surveillance will be conducted at various intervals. The intervals will be determined by the importance and complexity of each activity. Audit and surveillance intervals will be based on the schedule contained in Section 7.0. At a minimum, each of the field sampling activities described in Sections 6.2 will be monitored by an independent surveillance team at least once during the sampling process. EG&G will conduct audits of the laboratory contractor(s) as specified in the GRRASP, Parts A and B. The audits and surveillance, and activity Readiness Reviews are discussed further in Section 10.18.

#### 10.3.9 Data Reduction, Validation, and Reporting

##### 10.3.9.1 Analytical Reporting Turnaround Times

Analytical reporting turnaround times are as specified in Table 3-1 of Section 3.0 of the QAPjP.

##### 10.3.9.2 Data Reduction

Reduction of laboratory measurements shall be in accordance with the methods specified for each analytical method. Laboratory data will be compiled into sample data packages by the laboratory contractor. A sample data package shall be developed for each sample delivery group or sample batch, with separate data packages for each type of analysis (e.g., a data package for organics,

one for inorganics, one for water quality parameters, and one for radionuclides). The sample data package shall consist of a cover sheet/transmittal letter, a case narrative, data summary forms, and copies of the data checklists found in Attachments I in Parts A and B of the GRRASP. The reduced data will be used in the data validation process to verify that the laboratory control and the overall system DQOs have been met.

#### 10.3.9.3 Data Validation

Validation activities consist of reviewing and verifying field and laboratory data and evaluating these verified data for data quality (i.e., comparison of reduced data to DQOs, where appropriate). The field and laboratory data validation activities and guidelines are described and referenced in Section 3.0 of the QAPjP. The process for validating the quality of the data is illustrated graphically in Figure 3-1 of Section 3.0 of the QAPjP, and is also included as part of the sample collection, chain-of-custody, and analysis process illustrated in Figure 8-1 of Section 8.0 of the QAPjP. The criteria for determining the validity of ER data at Rocky Flats are described in subsection 3.3.7 of Section 3.0 of the QAPjP.

#### 10.3.9.4 Data Reporting

Depending on the data validation process, data are flagged as either "valid," "acceptable with qualifications," or "rejected." The results of the data validation shall be reported in ER Department Data Assessment Summary reports. The usability of data (the criteria of which is also described in subsection 3.3.7 of Section 3.0 of the QAPjP) shall also be addressed by the RFI Project Manager.

## **10.4 PROCUREMENT DOCUMENT CONTROL**

Procurement documents for items and services, including services for conducting field investigations and analytical laboratories, shall be prepared, handled, and controlled in accordance with the requirements and methods specified in Section 4.0 of the QAPjP.

## **10.5 INSTRUCTIONS, PROCEDURES, AND DRAWINGS**

The OU13 WP describes the activities to be performed. The OU13 WP will be reviewed and approved in accordance with the requirements for instructions, procedures, and drawings outlined in Section 5.0 of the QAPjP.

EMD OPS approved for use are identified in Table 10.1, which also indicates their applicability. Any additional quality-affecting procedures proposed for use but not identified in Table 10.1 will be developed and approved as required by Section 5.0 of the QAPjP prior to performing the affected activity.

Changes and variances to approved operating procedures shall be documented through preparation of Document Change Notices (DCNs), which will be prepared, reviewed, and approved in accordance with requirements specified in Section 5.0 of the QAPjP. (Note: DCNs were referred to as Procedure Change Notices in Revision 0 of the QAPjP). Any changes, revisions, additions, or deletions to the OU13 WP will be presented in either DCNs or Technical Memoranda. DCNs and Technical Memoranda will be reviewed and approved by the same organizations that reviewed and approved the original OU13 WP.

## **10.6 DOCUMENT CONTROL**

The following documents will be controlled in accordance with Section 6.0 of the QAPjP:

- Phase I RFI/RI Work Plan for the 100 Area, Operable Unit No. 13
- Rocky Flats Plant Site-Wide Quality Assurance Project Plan for CERCLA Remedial Investigation/Feasibility Studies and RCRA Facility Investigations/Corrective Measures Studies Activities (QAPjP)
- Quality Assurance Addendum (QAA) to the Rocky Flats Site-Wide QAPjP for Operable Unit No. 13, 100 Area, Phase I RFI/RI Activities
- EMD Operating Procedures and EM Radiological Guidelines (all operating procedures specified in the QAPjP, this QAA, and to-be-developed laboratory SOPs).

## **10.7 CONTROL OF PURCHASED ITEMS AND SERVICES**

Contractors that provide services to support the OU13 Phase I RFI/RI activities will be selected and evaluated as outlined in Section 7.0 of the QAPjP. This includes pre-award evaluation/audit of proposed contractors as well as periodic audit of the acceptability of contractor performance during the life of the contract. Any items or materials that are purchased for use for investigations at OU13 that have the ability to affect the quality of the data shall be inspected upon receipt.



## 10.8 IDENTIFICATION AND CONTROL OF ITEMS, SAMPLES, AND DATA

### 10.8.1 Sample Containers/Preservation

Appropriate volumes, containers, preservation requirements, and holding times for water and soil samples were presented in Table 6.2.

### 10.8.2 Sample Identification

RFI/RI samples shall be labeled and identified in accordance with Section 8.0 of the QAPjP and OPS-FO.13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples. Samples shall have unique identification that traces the sample to the source(s) and indicates the method(s), date, the sampler(s), and conditions prevailing at the time of sampling.

### 10.8.3 Chain-of-Custody

Sample chain-of-custody will be maintained through the application of OPS-FO. 13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples, and as illustrated in Figure 8-1 of the QAPjP for all environmental samples collected during field investigations.

## 10.9 CONTROL OF PROCESSES

The overall process of collecting samples, performing analysis, and entering the data into a database is considered a process that requires control. The process is controlled through a series of written procedures that govern and document the work activities. A process diagram is shown in Section 8.0 of the QAPjP.

## 10.10 INSPECTION

Procured materials and construction activities (e.g., groundwater monitoring well installation) shall be inspected (as applicable) in accordance with the requirements specified in Section 10.0 of the QAPjP.

## 10.11 TEST CONTROL

Test control requirements specified in Section 11.0 of the QAPjP are not applicable to any of the RFI/RI investigations described in the OU13 WP.

## 10.12 CONTROL OF MEASURING AND TEST EQUIPMENT (M&TE)

### 10.12.1 Field Equipment

Specific conductivity, temperature, and pH of groundwater samples shall be measured in the field. Field measurements will be taken and the instruments calibrated as specified in OPS-GW.05, Field Measurements for Groundwater Field Parameters. Measurements shall be made using the following equipment (or EG&G-approved alternates):

- Temperature: mercury-filled, teflon-coated, safety-type thermometer (VWR catalogue No. 6107-832 or equivalent), or digital readout thermistor (VWR catalogue No. 61017-562 or equivalent)
- Specific Conductivity: HACH 44600 Conductivity/TDS Meter
- pH: HACH One pH Meter (this meter may also be used for temperature measurements)

In addition to the field measurements for water quality, field measurements for radiation and soil gas will also be made. The following instruments will be used for these measurements.

- Radiological field readings for field survey grid locations will be measured with a High Purity Germanium (HPGe) detector. An SOP for the performance of surveys with the HPGe are under development by EG&G.
- Field readings for soil gas will be taken using a field gas chromatograph. These analyses will be performed in accordance with OPS-GT.09, Soil Gas Sampling and Field Analysis, and OPS-GT.19, Field Gas Chromatographs.

Each piece of field equipment shall have a file that contains:

- Specific model and instrument serial number
- Operating instructions
- Routine preventative maintenance procedures, including a list of critical spare parts to be provided or available in the field
- Calibration methods, frequency, and description of the calibration solutions
- Standardization procedures (traceability to nationally recognized standards).

The above information shall, in general, conform to the manufacturer's recommended operating instructions or shall explain the deviation from said instructions.

#### 10.12.2 Laboratory Equipment

Laboratory analyses will be performed by contracted laboratories. The equipment used to analyze environmental samples shall be calibrated, maintained, and controlled in accordance with the requirements contained in the specific analytical protocols used as specified in the GRRASP. This information will be supplied to EG&G as a laboratory SOP.

### **10.13 HANDLING, STORAGE, AND SHIPPING**

Samples shall be packaged, transported, and stored in accordance with OPS-FO.13, Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples. Maximum sample holding times, sample preservative, sample volumes, and sample containers were specified in Table 6.2. Those requirements are generally consistent with the sample holding time, preservative, and sample container requirements specified in Table 8-1 of Section 8.0 of the QAPjP. Sample handling and storage controls at the laboratory shall be provided as a laboratory SOP.

### **10.14 STATUS OF INSPECTION, TEST, AND OPERATIONS**

The requirements for the identification of inspection, test, and operating status shall be implemented as specified in Section 14.0 of the QAPjP. A log specifying the status of all boreholes and groundwater monitoring wells shall be maintained by the Field Activities Task Leader, which will include well/borehole identification number, ground elevation, casing depth of hole, depth to bedrock, static water level (as applicable), depth to top and bottom of screen (as applicable), diameter of hole, diameter of casing, and top/bottom of casing.

### **10.15 CONTROL OF NONCONFORMANCES**

The requirements for the identification, control, evaluation, and disposition of nonconforming items, samples, and data will be implemented as specified in Section 15.0 of the QAPjP. Nonconformances identified by the implementing contractor shall be submitted to EG&G for processing as outlined in the QAPjP.

### **10.16 CORRECTIVE ACTION**

The requirements for the identification, documentation, and verification of corrective actions for conditions adverse to quality will be implemented as outlined in Section 16.0 of the QAPjP. Conditions adverse to quality identified by the implementing contractor shall be documented and submitted to EG&G for processing as outlined in the QAPjP.

#### **10.17 QUALITY ASSURANCE RECORDS**

QA records will be controlled in accordance with OPS-FO.02, Field Document Control. QA records to be generated during OUI3 RFI/RI activities include, but are not limited to:

- Field Logs and Data Record Forms (e.g., sample collection notebooks/logs for groundwater, sediment, and air)
- Calibration Records
- Sample Collection and Chain-of-Custody Records
- Laboratory Sample Data Packages
- Drilling Logs
- Work Plan/Field Sampling Plan
- QAPjP/QAA
- Audit/Surveillance/inspection Reports
- Nonconformance Reports
- Corrective Action Documentation
- Data Validation Results
- Data Reports

- Procurement/Contracting Documentation
- Training/Qualification Records
- Inspection Records

## 10.18 QUALITY VERIFICATION

The requirements for the verification of quality shall be implemented as specified in Section No. 18 of the QAPJP. EG&G will conduct audits of the laboratory contractor as specified in the GRRASP, Parts A and B. The EMD GAPM shall develop a surveillance schedule with the surveillance intervals based on the importance and complexity of each sampling/analytical activity. Intervals will also be based on the schedule contained in Section 7.0.

Examples of some specific tasks that will be monitored by the surveillance program are as follows:

- Borings and well installations (approximately 10 percent of the holes)
- Field sampling (approximately 5 percent of each type of sample collected)
- Records management (a surveillance will be conducted once at the initiation of OU13 activities, and monthly thereafter)
- Data verification, validation, and reporting

Audits of contractors providing field investigation, construction, and analytical support services shall be performed at least annually or once during the life of the project, whichever is more frequent.

A Readiness Review shall be conducted by the EMD QAPM prior to the implementation of OU13 field investigation activities. The readiness review will determine if all activity prerequisites have been met that are required to begin work. The applicable requirements of the QAPjP and this QAA will be addressed.

#### 10.19 SOFTWARE CONTROL

The requirements for the control of software shall be implemented as specified in Section 19.0 of the QAPjP. Only database software is anticipated to be used for the OU13 WP activities. Operating procedures applicable to the use of the database storing environmental data can be found in OPS-FO.14, Field Data Management.

**ROCKY FLATS PLANT**  
**Phase I RFI/RI Work Plan**  
**Operable Unit 13**  
**100 Area**


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**Approved By:**

02/01/93  
**Effective Date**

  
**Manager**

10/9/92  
**Date**

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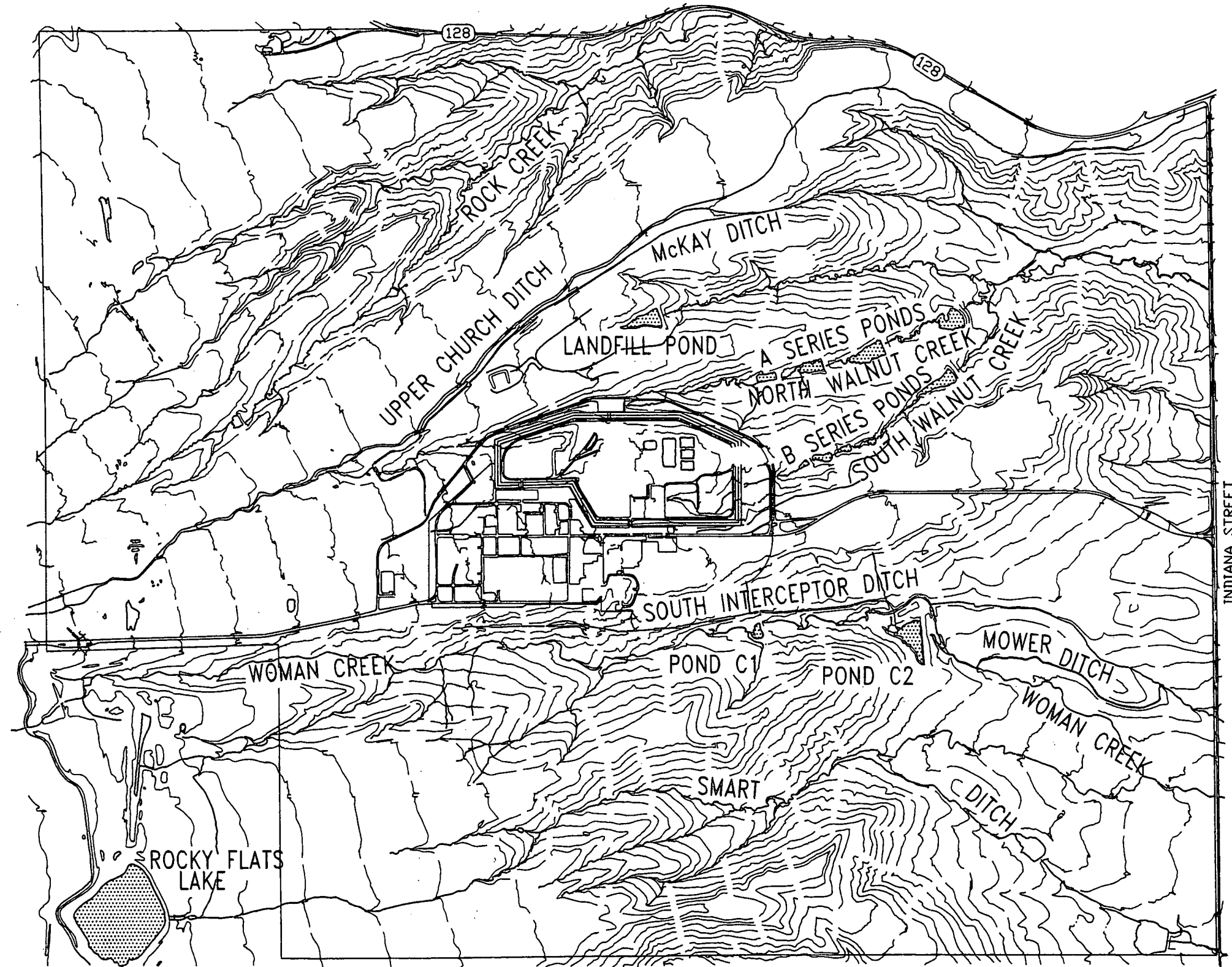
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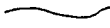
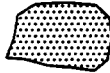




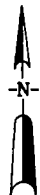
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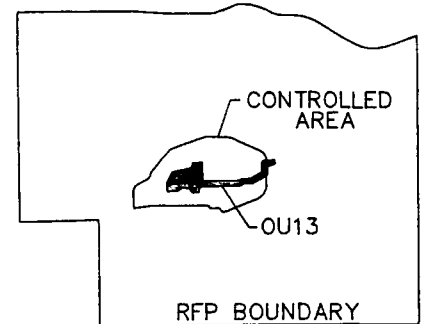
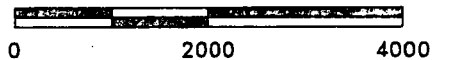


EXPLANATION

-  GROUND SURFACE CONTOURS
-  CURRENT RFP WATER STORAGE FACILITIES
-  PAVED ROADS
-  STREAMS, DITCHES, DRAINAGE FEATURES



FEET



U.S. DEPARTMENT OF ENERGY  
Rocky Flats Plant  
Golden Colorado

OPERABLE UNIT NO. 13  
PHASE II RFI/RI WORK PLAN

FIGURE 1-4

LOCATION OF SURFACE  
WATER FEATURES





# EXPLANATION

- Artificial Fill (RECENT)
- Valley Fill Alluvium (RECENT)
- Landslide Slump (RECENT)
- Undiff. Terrace Alluvium (PLEISTOCENE)
- Rocky Flats Alluvium (PLEISTOCENE)
- Arapahoe Formation (CRETACEOUS)
- Laramie Formation (CRETACEOUS)
- Fox Hills Sandstone (CRETACEOUS)
- Pierre Shale (CRETACEOUS)

Strike and dip of bedding planes in bedrock

- inclined
- vertical
- overturned
- horizontal

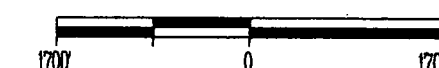
- Gravel, sand, or clay pit
- BM Benchmark

- Area of bedrock exposure

Contact  
dashed where approx located;  
dotted where concealed

From EG & G, 1992

SCALE 1" = 1700'

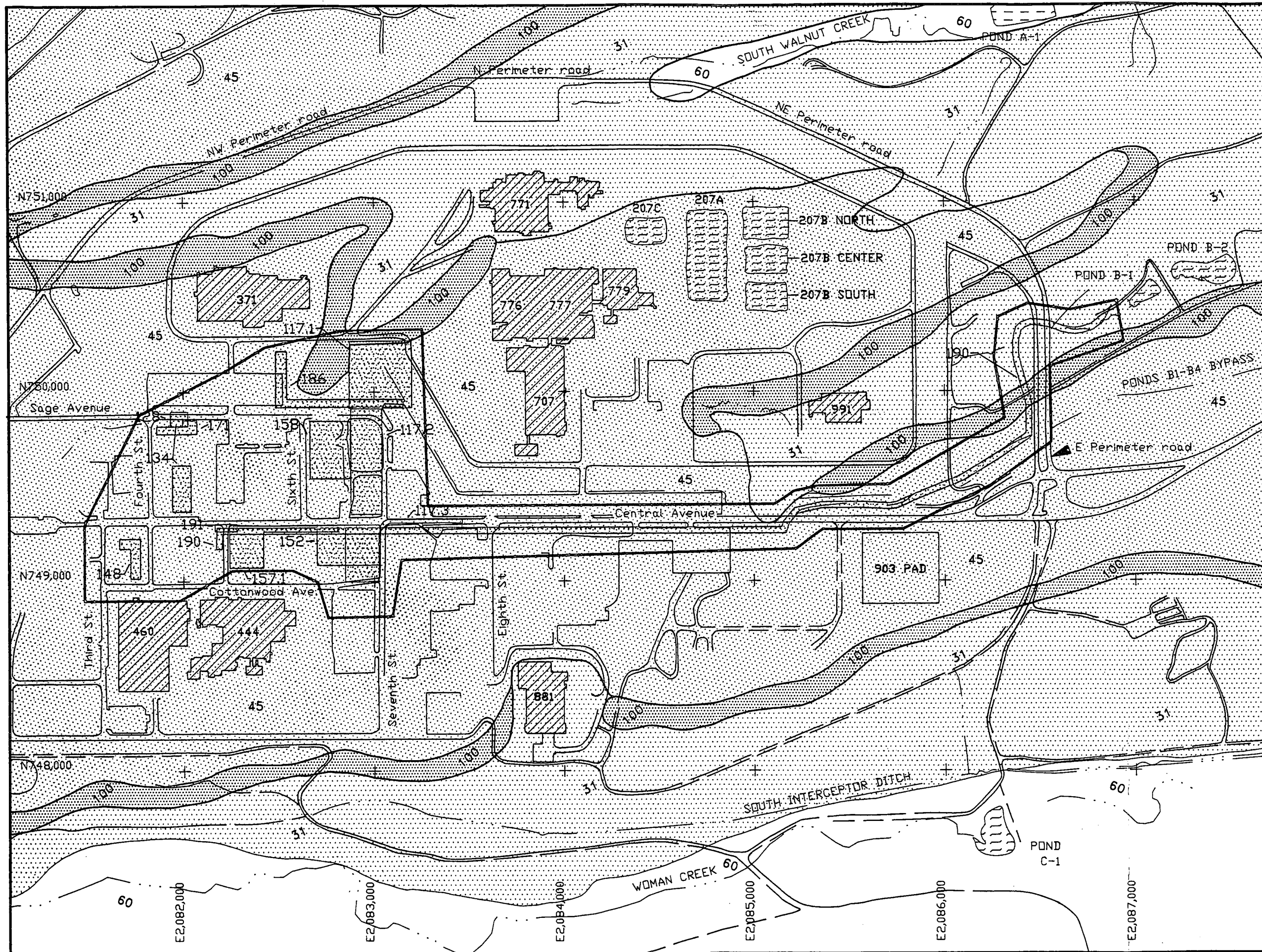


U.S. DEPARTMENT OF ENERGY  
Rocky Flats Plant, Golden, Colorado

FIGURE 1-9

SURFICIAL GEOLOGY  
FOR THE  
ROCKY FLATS PLANT





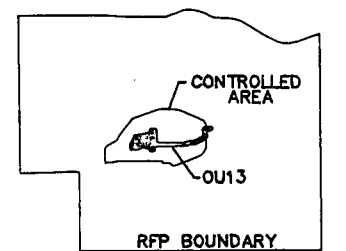
# MAP LEGEND

- OPERABLE UNIT
- STREAMS DITCHES DRAINAGE FEATURES
- == PAVED ROADS
- = = DIRT ROADS
- [Hatched Box] SURFACE WATER IMPOUNDMENTS
- [Hatched Box] BUILDINGS
- [Dotted Box] INDIVIDUAL HAZARDOUS SUBSTANCE SITES
- [Box with 100] 100 NEDERLAND
- [Box with 45] 45 FLATIRONS
- [Box with 31] 31 DENVER-KUTCH-MIDWAY
- [Box with 60] 60 DOES NOT OCCUR WITHIN OU 13 BOUNDARY



FEET

0 500 1000



U.S. DEPARTMENT OF ENERGY  
Rocky Flats Plant  
Golden Colorado

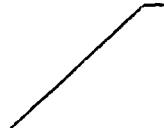
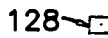
OPERABLE UNIT NO. 13  
PHASE II RFI/RI WORK PLAN


FIGURE 1-10

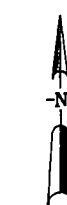
SOILS IN THE VICINITY  
OF ROCKY FLATS PLANT

SOURCE:  
SOIL CONSERVATION SERVICE, 1980.

LEGEND

 FENCE  
 128 & 134(N) INDIVIDUAL HAZARDOUS  
 SUBSTANCE SITES

 968 BUILDINGS



SCALE

0 500 1000

U.S. DEPARTMENT OF ENERGY  
Rocky Flats Plant  
Golden Colorado

OPERABLE UNIT NO. 13  
PHASE I RFI/RI WORK PLAN

**FIGURE 2-1**

**LOCATION OF BUILDINGS  
AND IHSSs IN OU13**

N751,000

N750,000 128 &amp; 134(N)

N749,000

E2,082,000

E2,083,000

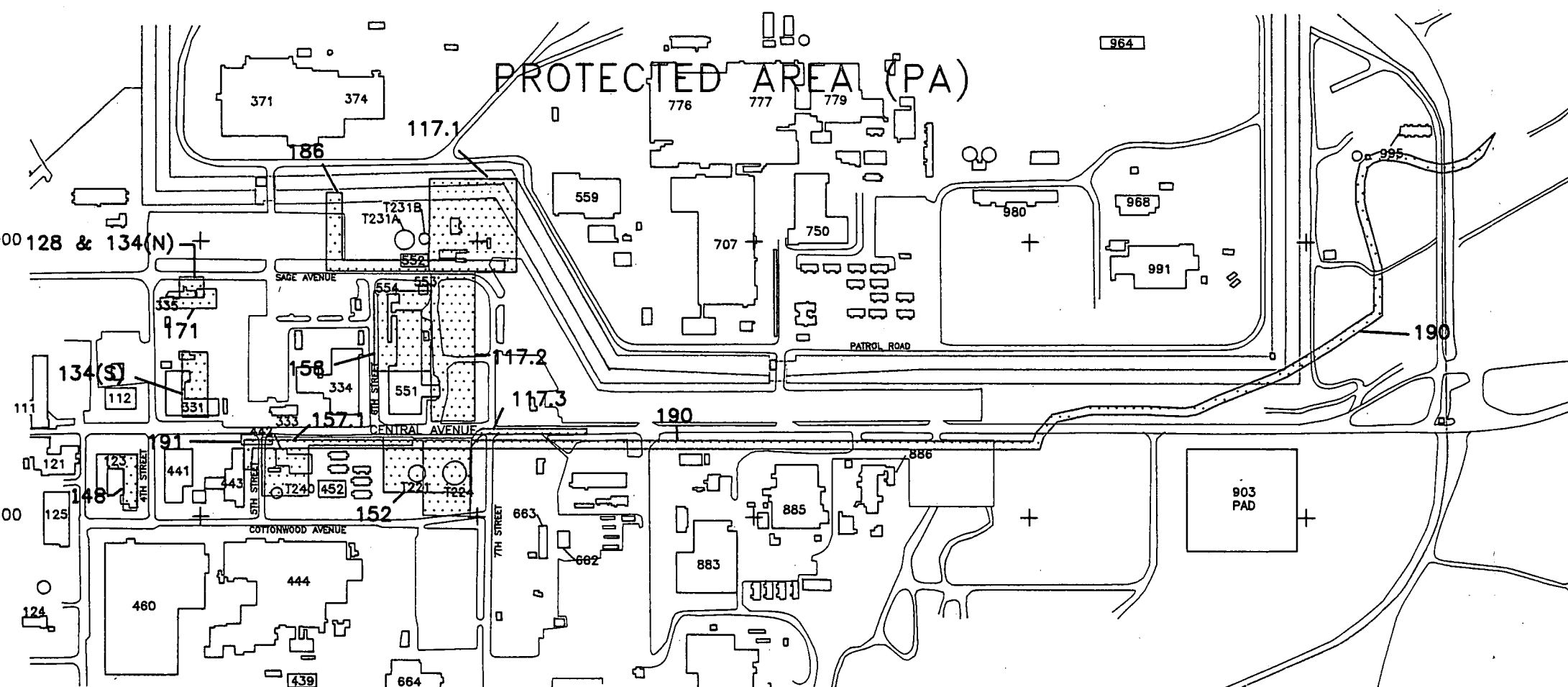
E2,084,000

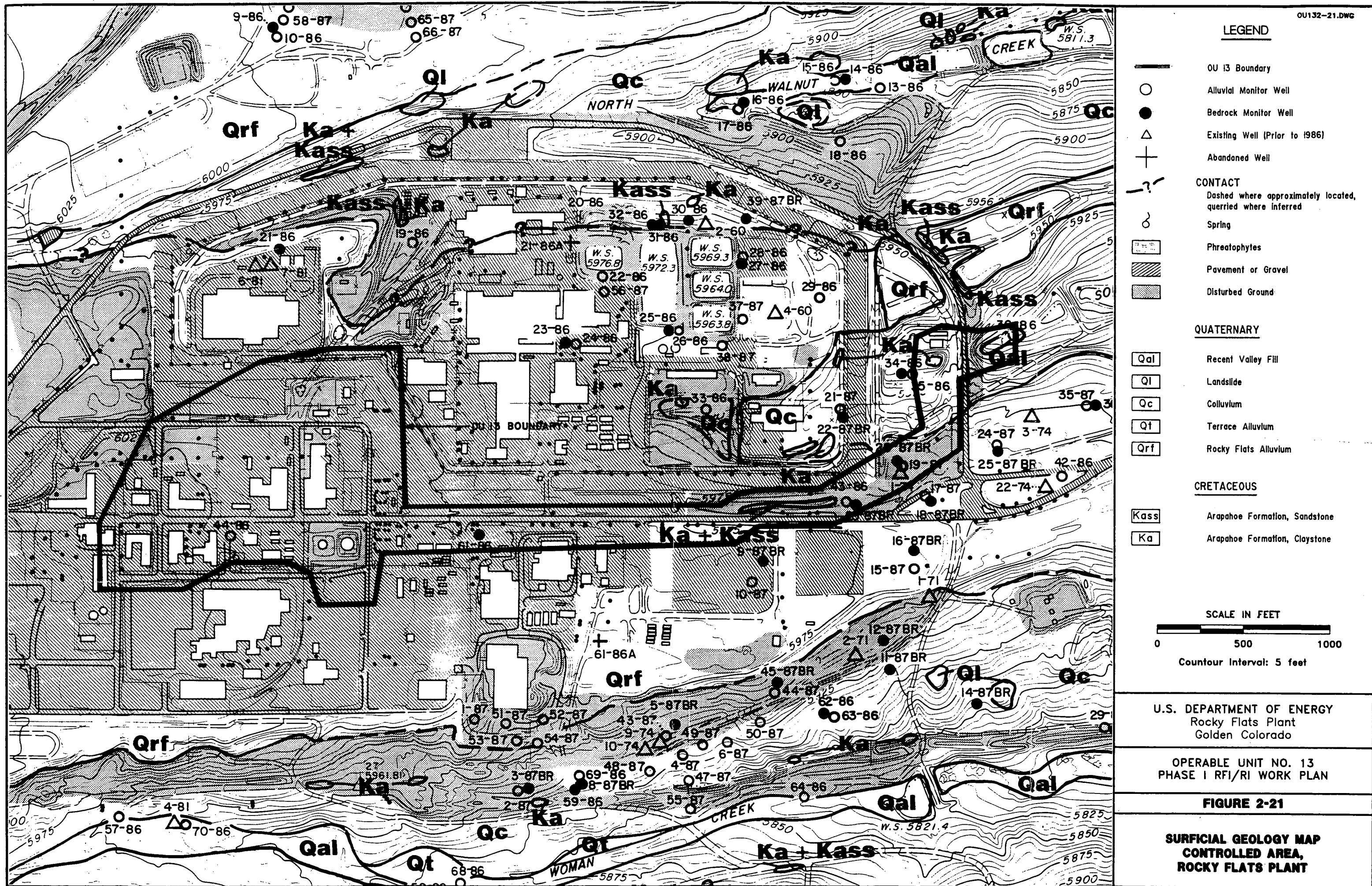
E2,085,000

E2,086,000

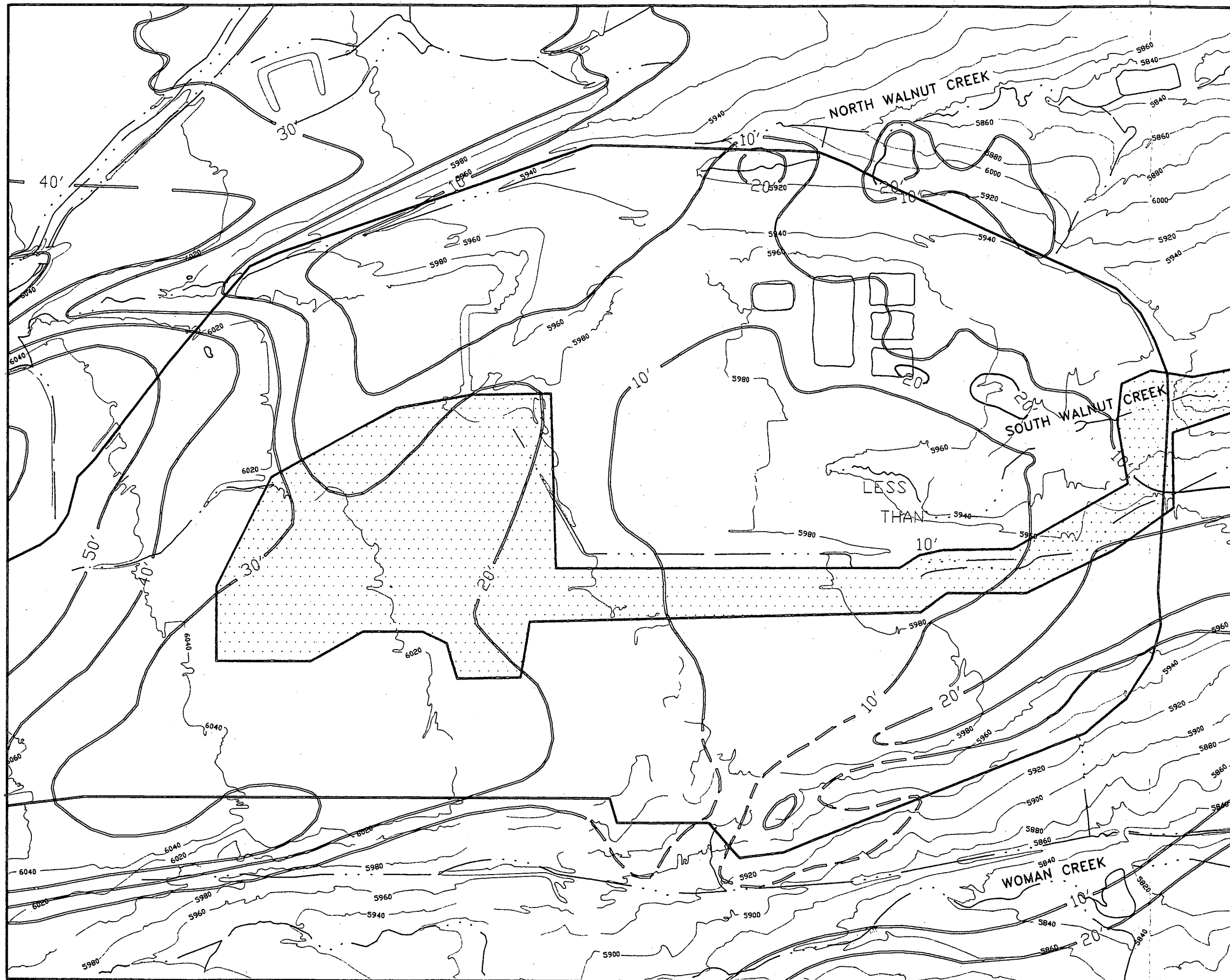
E2,087,000

PROTECTED AREA (PA)



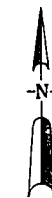




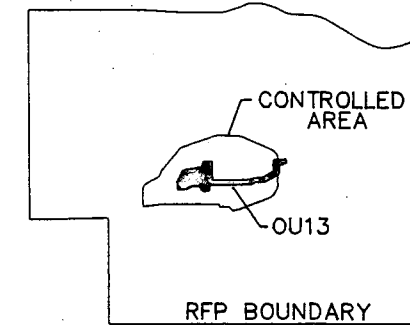
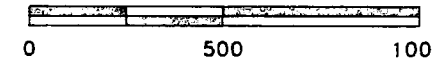


**LEGEND**

- 10' — ISOPACH FILL/ALLUVIUM
- 5860 — SURFACE ELEVATION  
(BROKEN WHERE INTERRUPTED  
BY BUILDINGS)
- CONTROLLED AREA
- OU 13 BOUNDARY
- STREAMS DITCHES  
DRAINAGE FEATURES



SCALE



U.S. DEPARTMENT OF ENERGY  
Rocky Flats Plant  
Golden Colorado

OPERABLE UNIT NO. 13  
PHASE II RFI/RI WORK PLAN

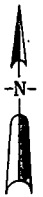
FIGURE 2-22

**MAP OF TOPOGRAPHY AND  
ISOPACH OF SURFICIAL MATERIALS  
AT THE CONTROLLED AREA,  
ROCKY FLATS PLANT**

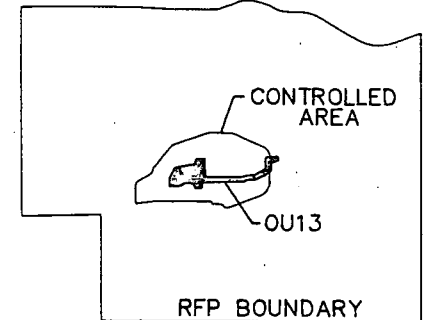
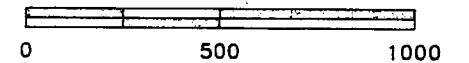


**LEGEND**

- 5940' — PEDIMENT ELEVATION
- 5880 — GROUND SURFACE ELEVATION
- PALEO RIDGE
- PALEO DRAINAGE
- OU 13 BOUNDARY
- CREEKS
- AREA SUBJECT TO EROSION AT PEDIMENT DUE TO LOSS OF ROCKY FLATS ALLUVIUM



SCALE

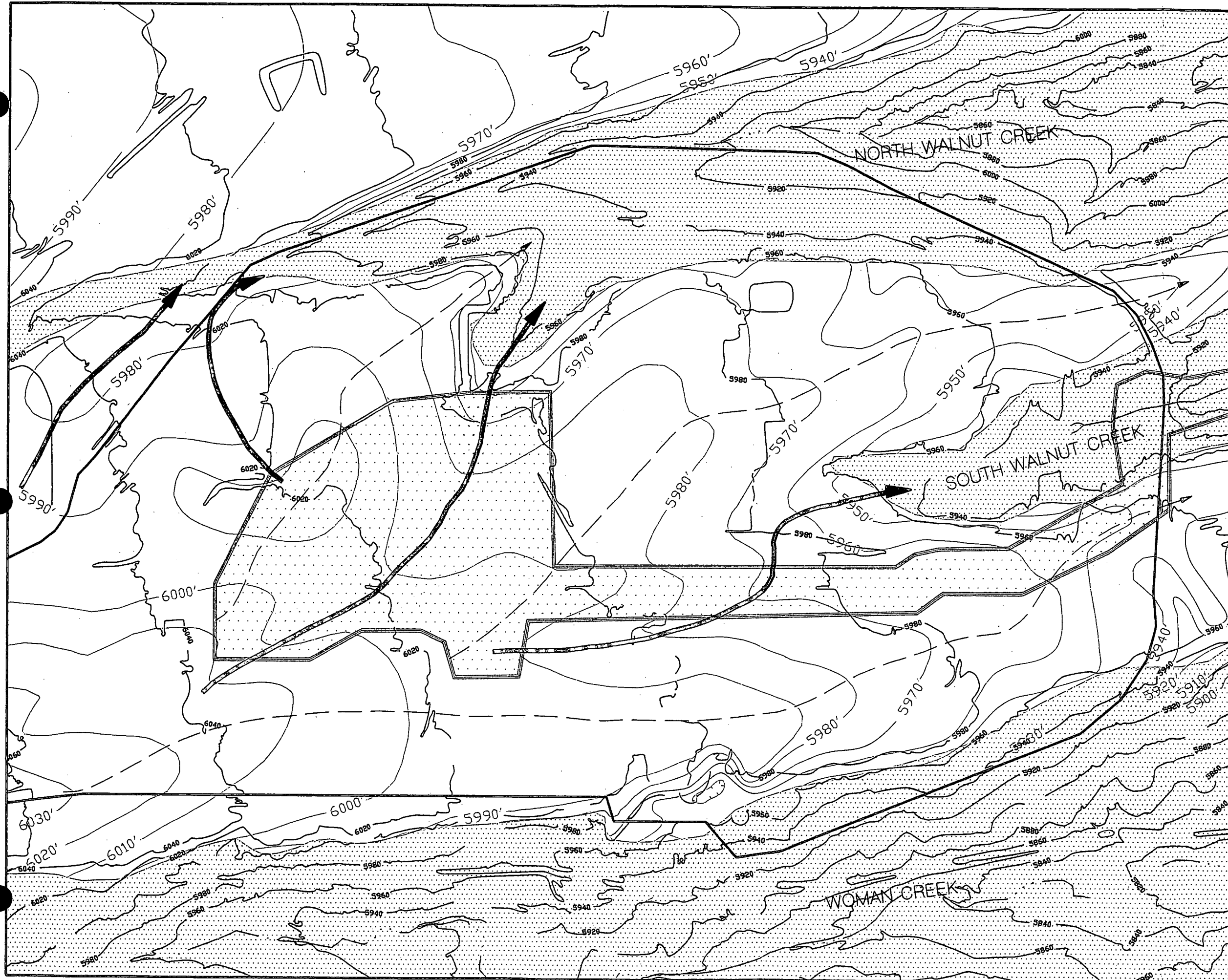


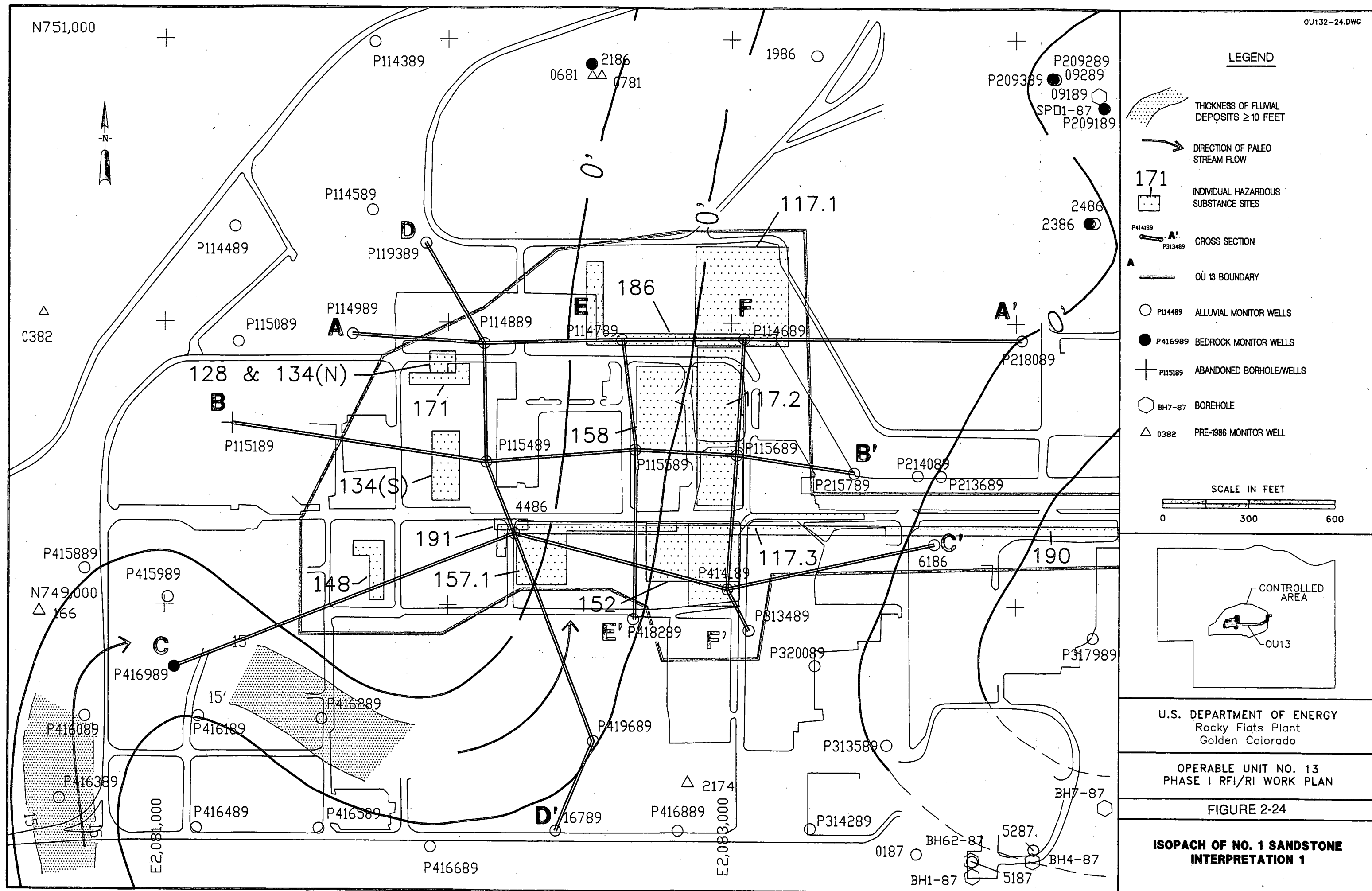
U.S. DEPARTMENT OF ENERGY  
Rocky Flats Plant  
Golden Colorado

OPERABLE UNIT NO. 13  
PHASE II RFI/RI WORK PLAN

FIGURE 2-23

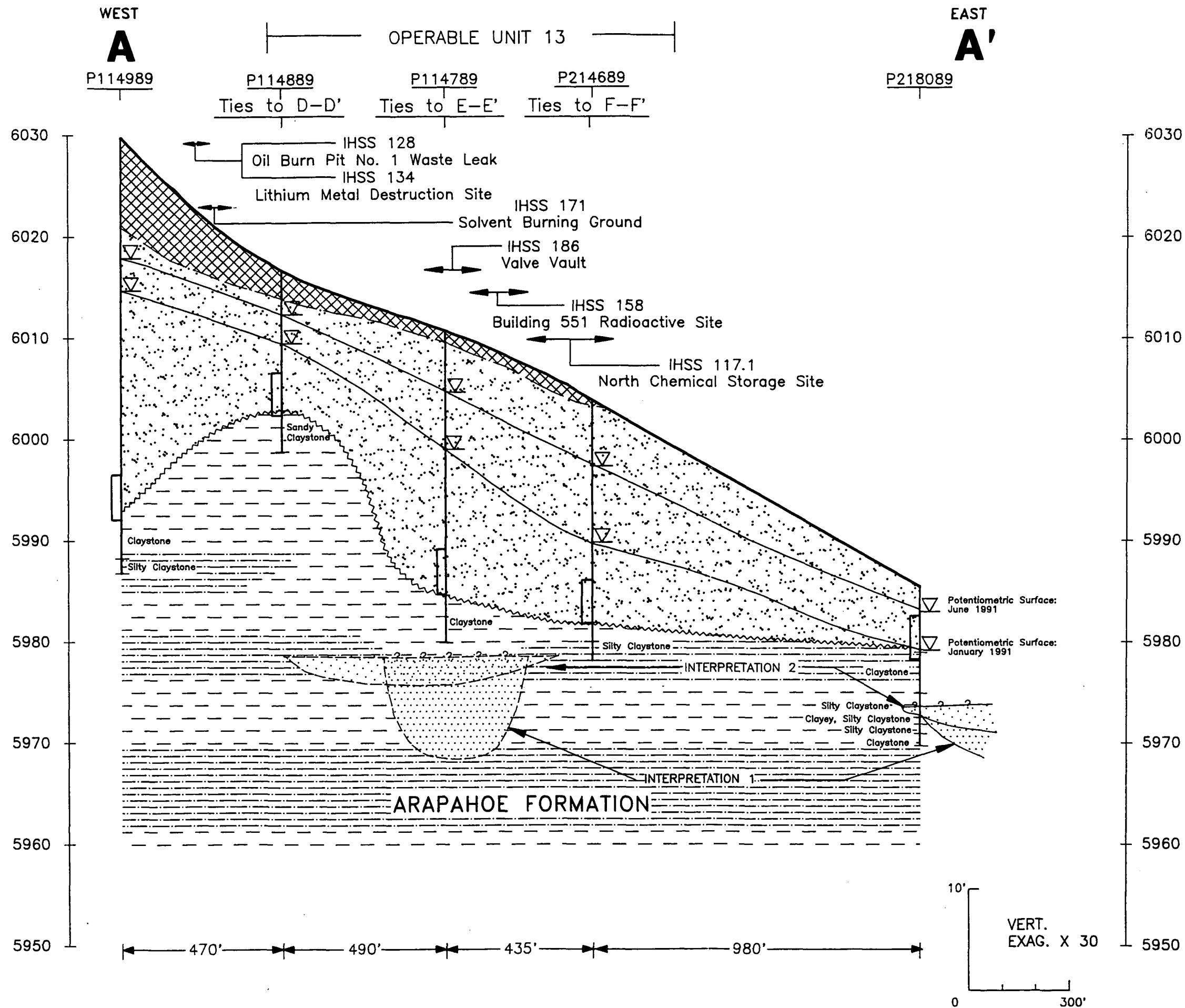
**MAP OF PRESENT-DAY TOPOGRAPHY  
AND SUBSURFACE, PRESERVED  
PRE-ROCKY FLATS ALLUVIUM  
PEDIMENT SURFACE**





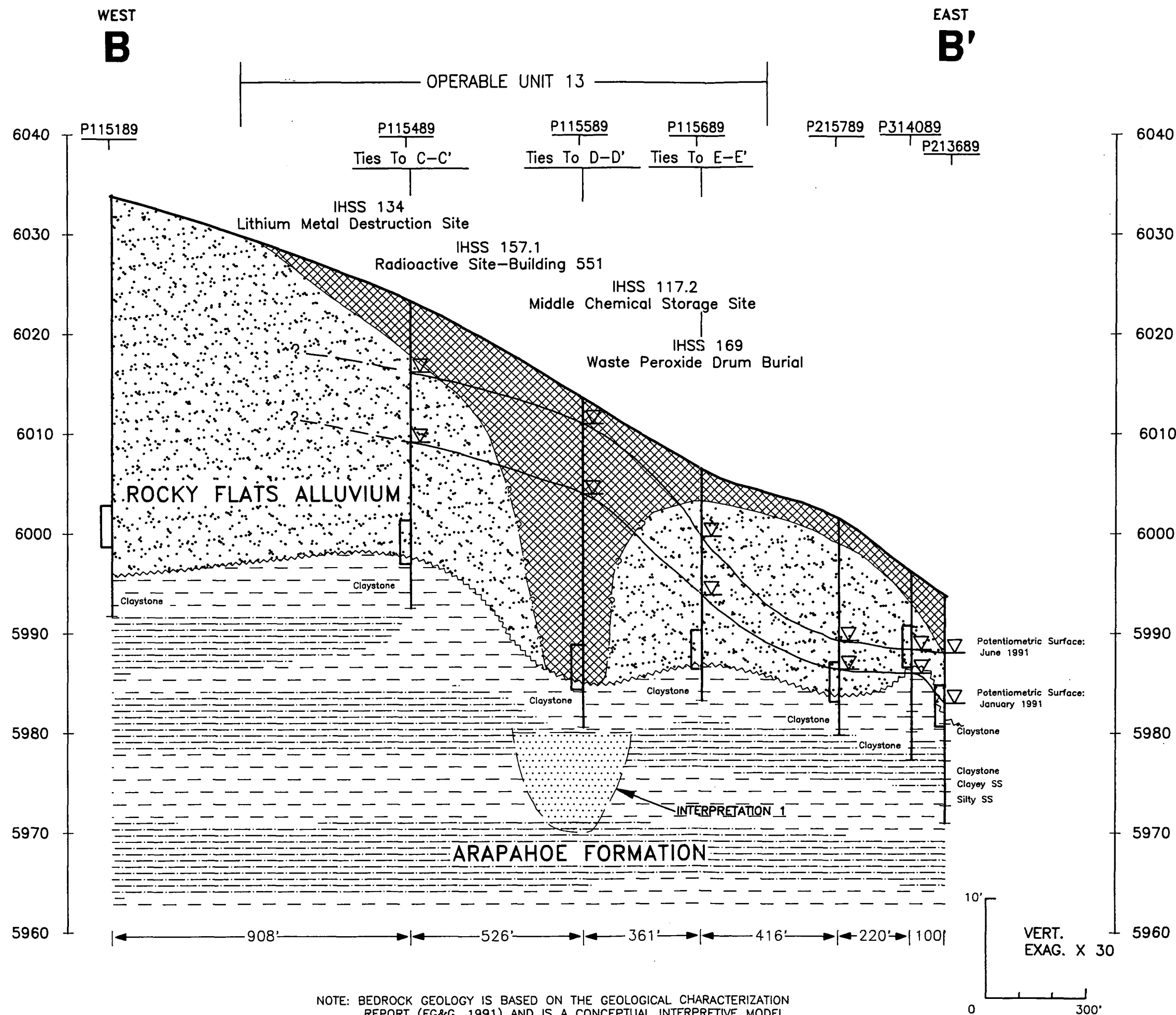


Elevation in Feet MSL



NOTE: BEDROCK GEOLOGY IS BASED ON THE GEOLOGICAL CHARACTERIZATION REPORT (EG&G, 1991) AND IS A CONCEPTUAL INTERPRETIVE MODEL.

Elevation in Feet MSL

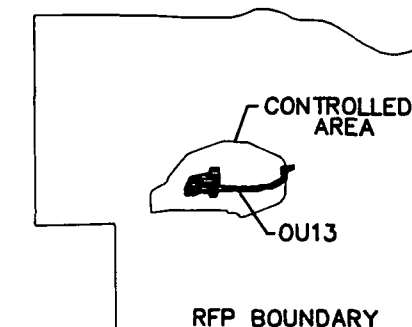
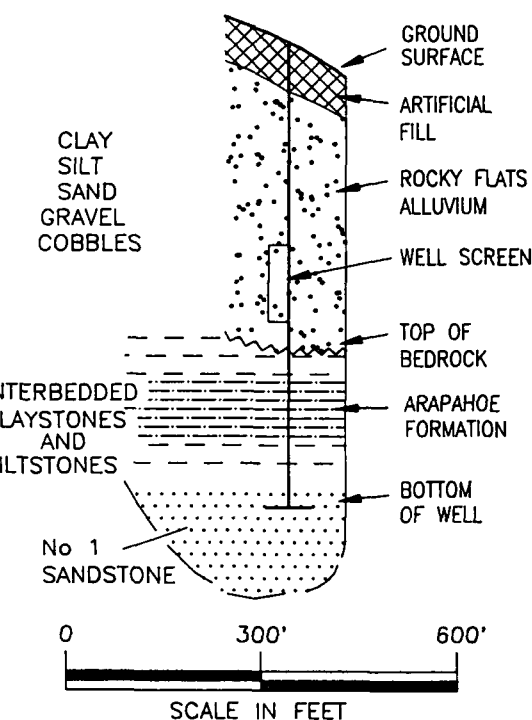


LEGEND

OU132-27.DWG

P215789 WELL NO.  
SEQUENCE  
QUADRANT  
YEAR DRILLED

GEOLOGICAL LITHOLOGIES



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Rocky Flats Plant  
Golden Colorado

OPERABLE UNIT NO. 13  
PHASE I RFI/RI WORK PLAN

FIGURE 2-27

GEOLOGICAL CROSS-SECTION  
B-B'

Reference Figures 2-5 & 2-6





NORTH  
**D**

SOUTH  
**D'**

P119389

P114889

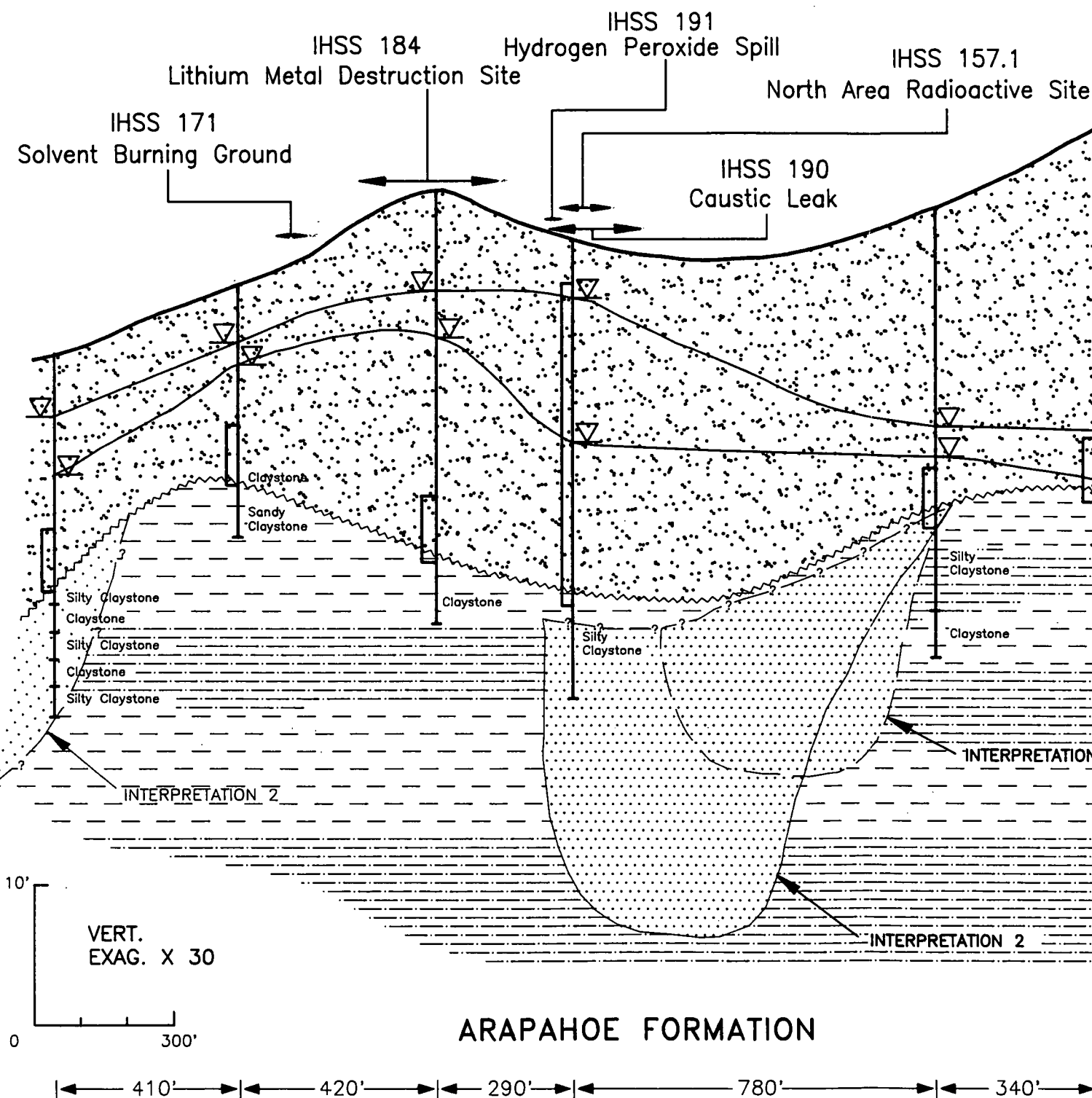
P115489

44-86

P419689

P116789

OPERABLE UNIT 13

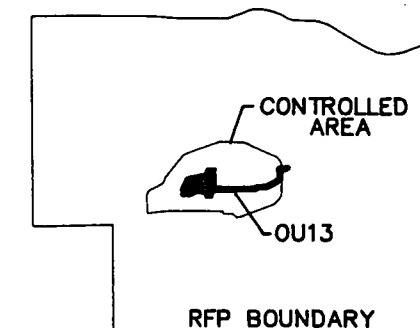
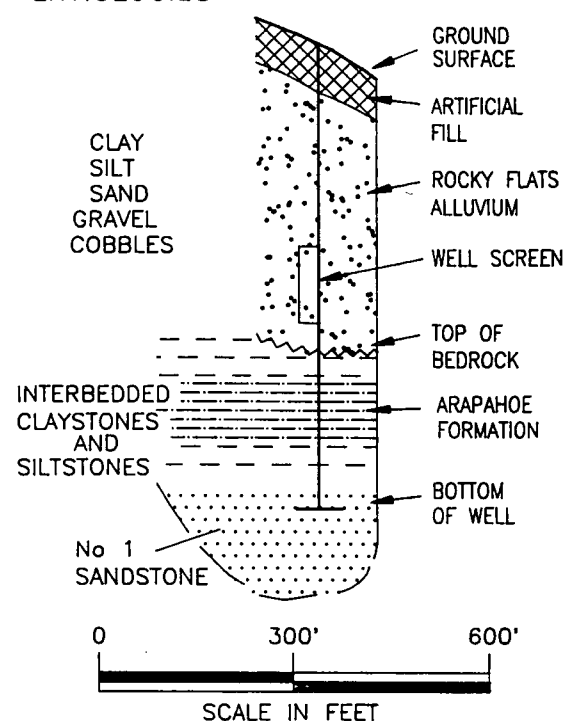


LEGEND

OU132-29.DWG

P215789 WELL NO.  
SEQUENCE  
QUADRANT  
YEAR DRILLED

GEOLOGICAL  
LITHOLOGIES



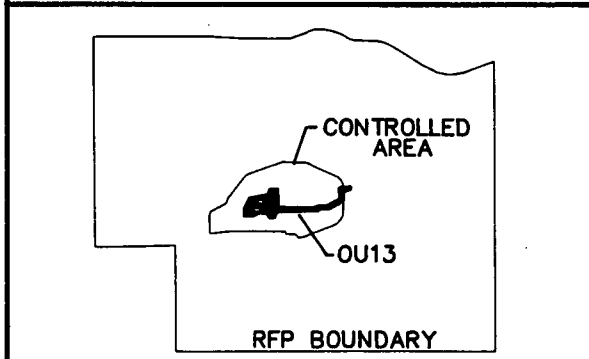
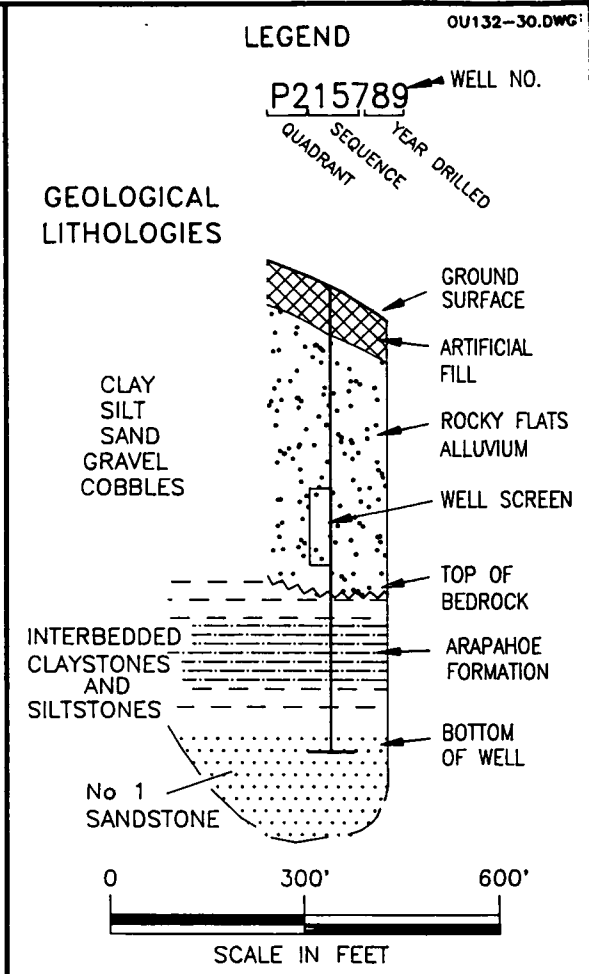
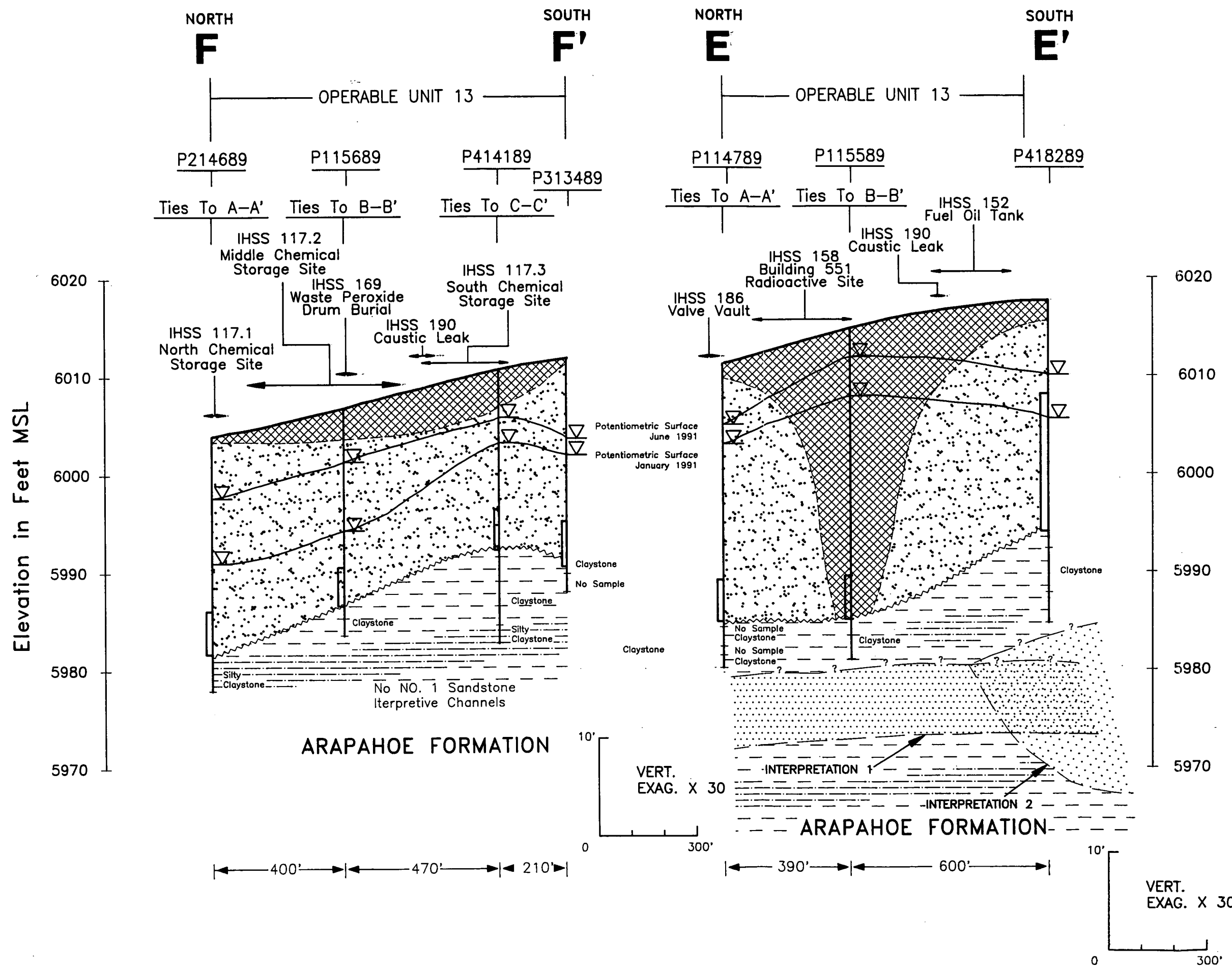
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Golden Colorado

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PHASE I RFI/RI WORK PLAN

FIGURE 2-29

**GEOLOGICAL CROSS-SECTION  
D-D'**

Reference Figures 2-5 & 2-6



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Rocky Flats Plant  
Golden Colorado

OPERABLE UNIT NO. 13  
PHASE IIRFI/RI WORK PLAN

FIGURE 2-30

**GEOLOGICAL CROSS-SECTION  
E-E' & F-F'**

Reference Figures 2-5 & 2-6

NOTE: BEDROCK GEOLOGY IS BASED ON THE GEOLOGICAL CHARACTERIZATION REPORT (EG&G, 1991) AND IS A CONCEPTUAL INTERPRETIVE MODEL.



# LEGEND

DATA POINTS ARE FROM WELLS  
OPEN TO THE UPPERMOST  
HYDROSTRATIGRAPHIC UNIT

x WATER LEVEL ELEVATION  
ABOVE SEA LEVEL

6012 CONTOURS  
WATER LEVEL ELEVATION

5996 CONTOURS  
GROUND SURFACE

171  
INDIVIDUAL HAZARDOUS  
SUBSTANCE SITES

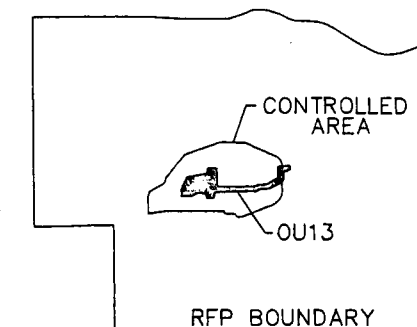
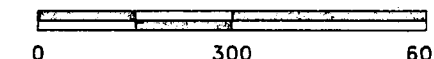
OU 13 BOUNDARY

- ALLUVIAL WELL/PIEZOMETER
- BEDROCK WELL
- ◻ BOREHOLE
- △ PRE-1986 MONITORING WELL

ALL WATER LEVEL ELEVATION DATA  
COLLECTED JUNE, 1991

CONTOUR INTERVAL: 2'

SCALE

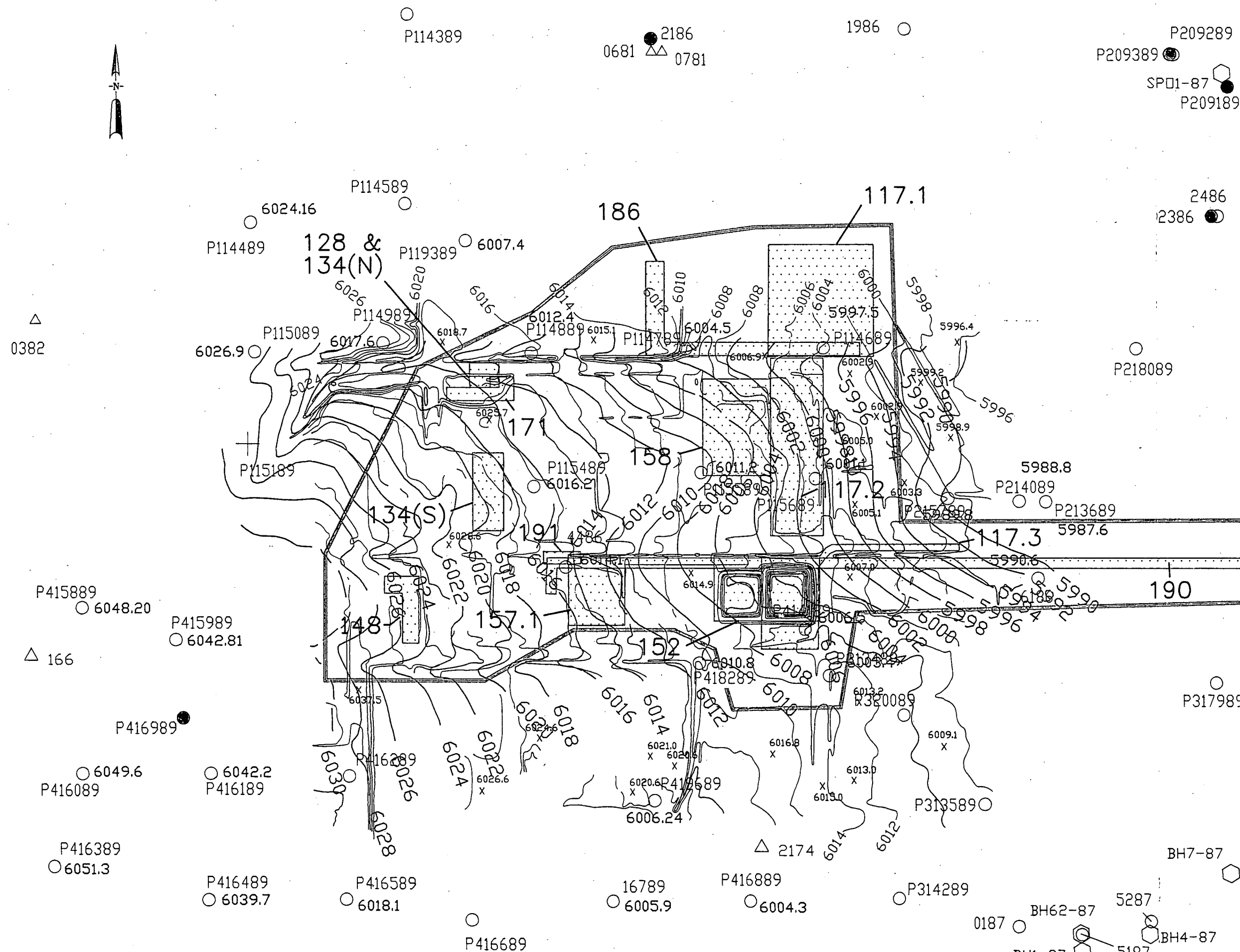


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Rocky Flats Plant  
Golden Colorado

OPERABLE UNIT NO. 13  
PHASE I RFI/RI WORK PLAN

FIGURE 2-31

**HIGH WATER LEVEL  
POTENTIOMETRIC SURFACE MAP  
UPPERMOST HYDROSTRATIGRAPHIC UNIT**





6042.2 WATER LEVEL ELEVATION  
ABOVE SEA LEVEL

6012- CONTOURS  
WATER LEVEL ELEVATION

5996 CONTOURS  
GROUND SURFACE

171  
INDIVIDUAL HAZARDOUS  
SUBSTANCE SITES

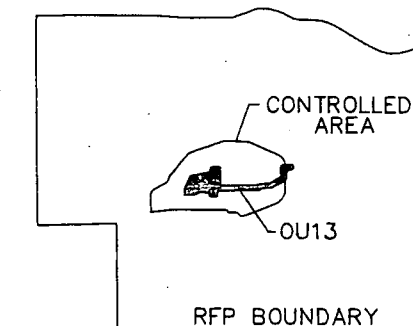
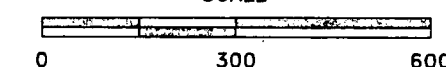
OU 13 BOUNDARY

○ ALLUVIAL WELL/PIEZOMETER  
● BEDROCK WELL  
⬡ BOREHOLE  
△ PRE-1986 MONITORING WELL

ALL WATER LEVEL ELEVATION DATA  
DATA COLLECTED JAN. 1991

CONTOUR INTERVAL: 2'

SCALE











U.S. DEPARTMENT OF ENERGY  
Rocky Flats Plant  
Golden Colorado

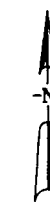
OPERABLE UNIT NO. 13  
PHASE I RFI/RI WORK PLAN

FIGURE 2-32

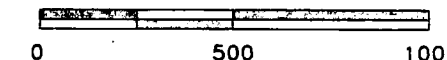
**LOW WATER LEVEL  
POTENTIOMETRIC SURFACE MAP  
UPPERMOST HYDROSTRATIGRAPHIC UNIT**

MAP LEGEND

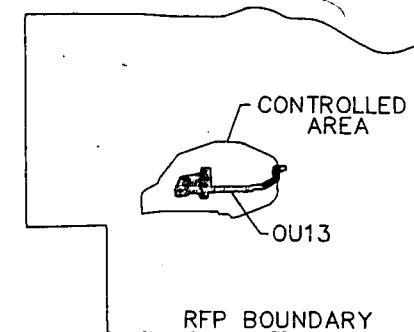
-  OPERABLE UNIT
-  STREAMS DITCHES DRAINAGE FEATURES
-  PAVED ROADS
-  DIRT ROADS
-  NORTH WALNUT CREEK DRAINAGE BASIN
-  UPPER S. WALNUT CREEK DRAINAGE BASIN
-  LOWER S. WALNUT CREEK DRAINAGE BASIN
-  CURRENT SURFACE WATER FLOW PATH



SCALE



SCALE: 1" = 500'

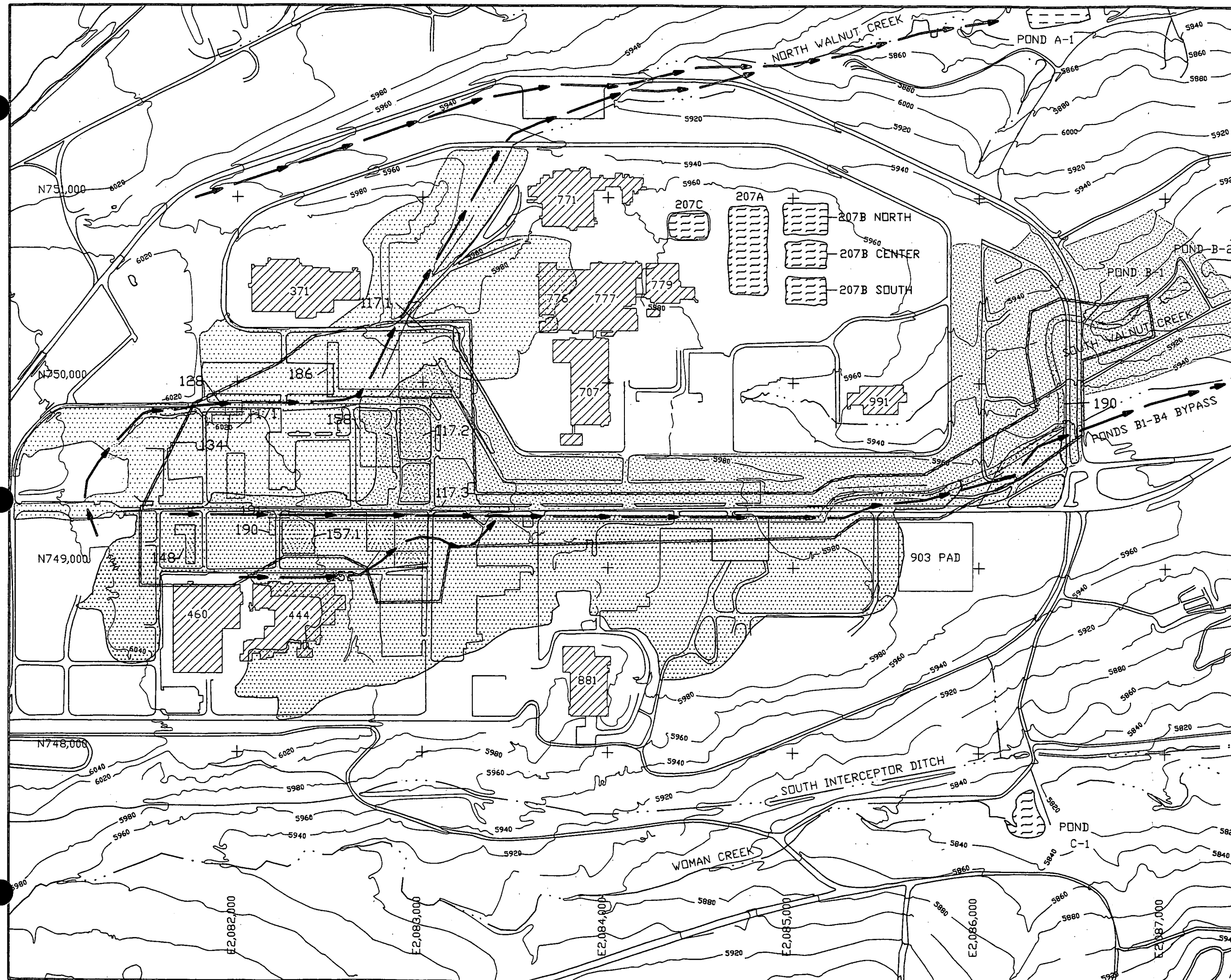


U.S. DEPARTMENT OF ENERGY  
Rocky Flats Plant  
Golden Colorado

OPERABLE UNIT NO. 13  
PHASE I RFI/RI WORK PLAN

FIGURE 2-33

**CURRENT SURFACE-WATER DRAINAGE  
BASINS AND PRIMARY DRAINAGE PATHS**



MAP LEGEND

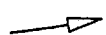
171



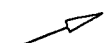
INDIVIDUAL HAZARDOUS  
SUBSTANCE SITES



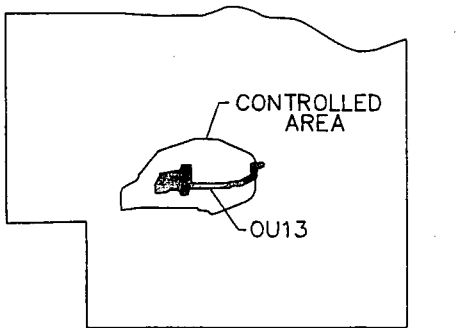
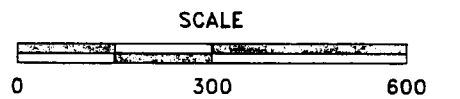
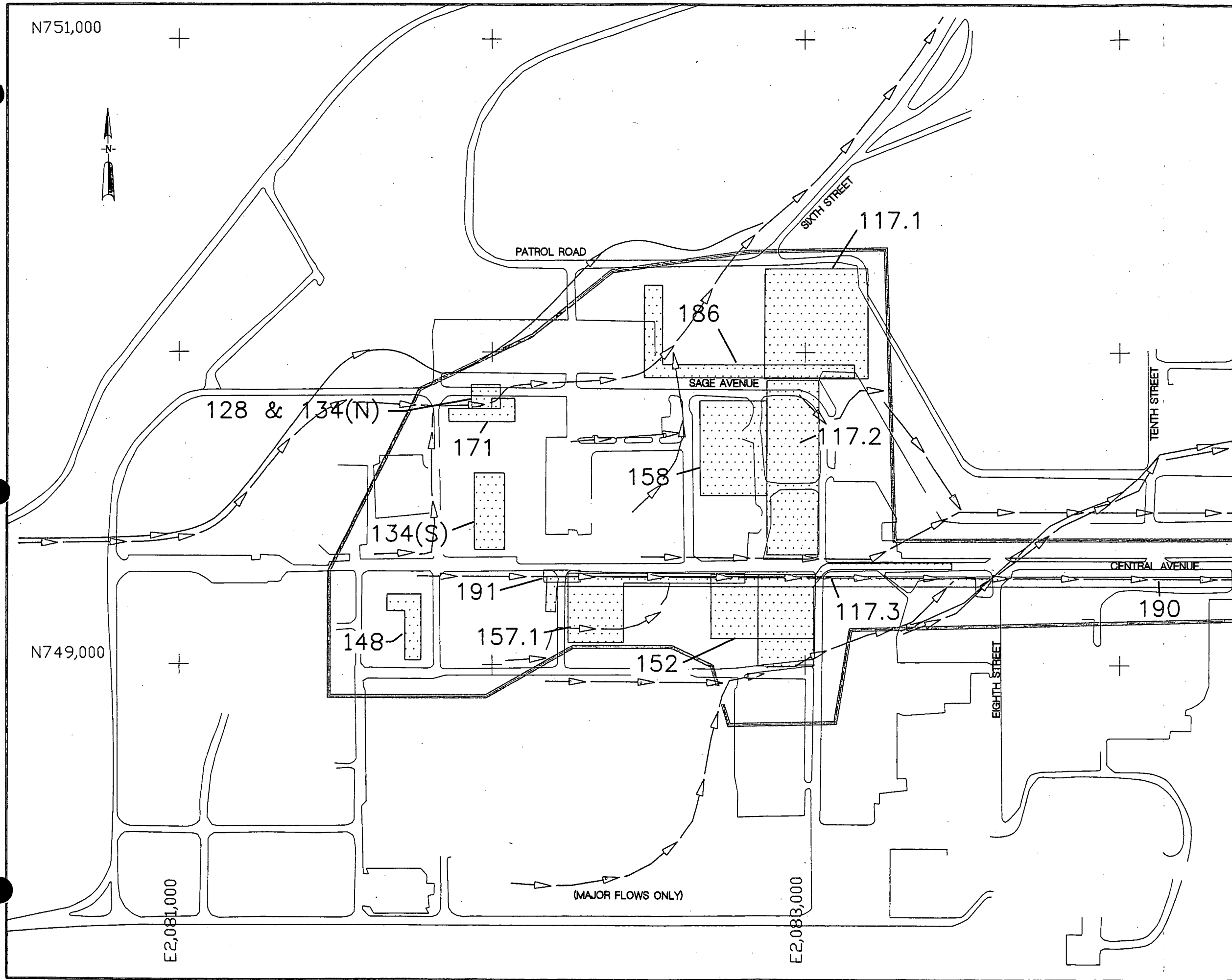
OU 13 BOUNDARY



CURRENT FLOW PATH



HISTORIC FLOW PATH (JULY, 1955)

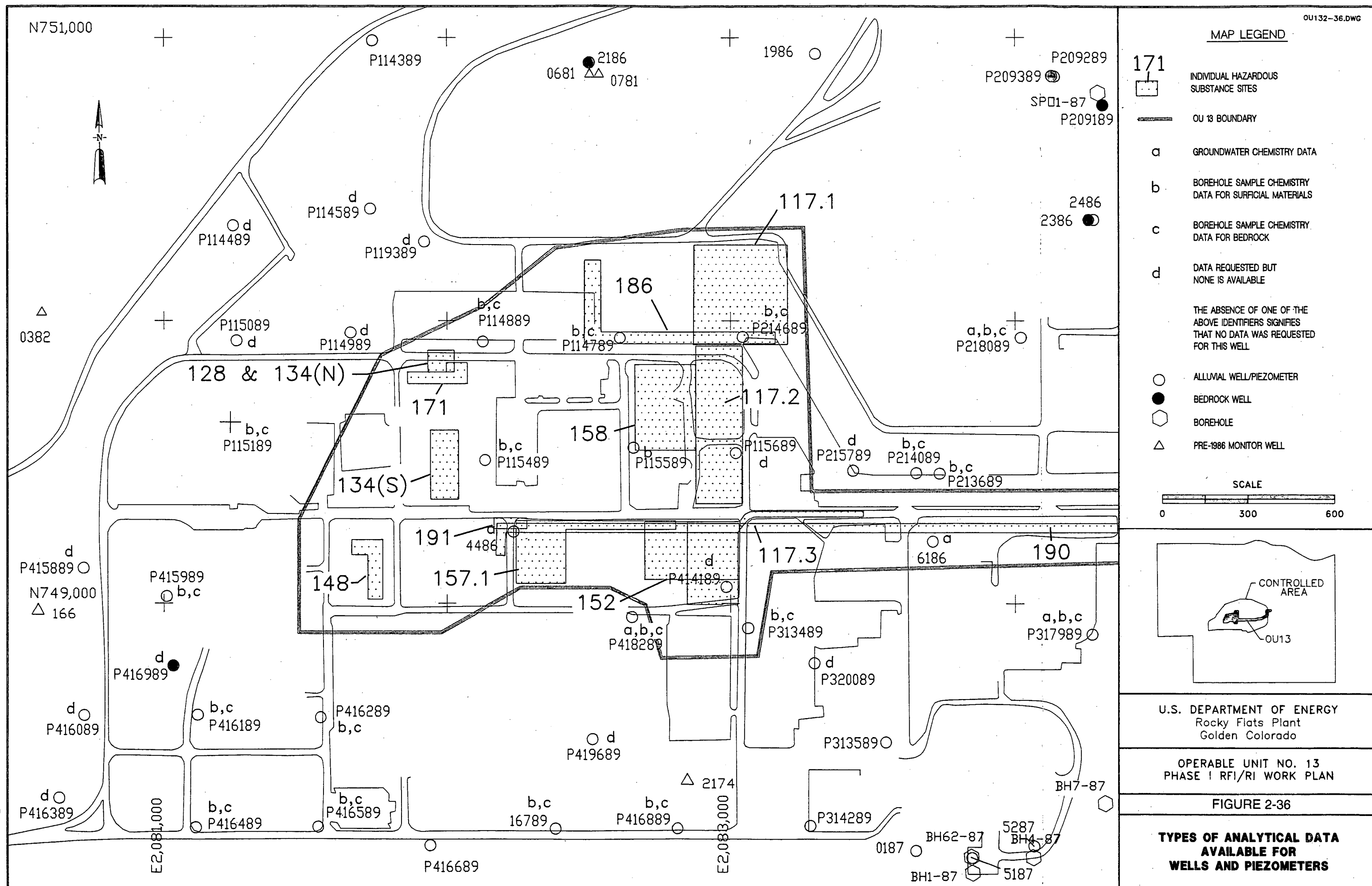


U.S. DEPARTMENT OF ENERGY  
Rocky Flats Plant  
Golden Colorado

OPERABLE UNIT NO. 13  
PHASE I RFI/RI WORK PLAN

FIGURE 2-34

**HISTORIC AND CURRENT  
DRAINAGE PATHS**



N751,000

N749,000

E2,081,000

E2,083,000

OU132-44.DWG

MAP LEGEND

171

INDIVIDUAL HAZARDOUS  
SUBSTANCE SITES

OU 13 BOUNDARY

NA

DATA REQUESTED BUT  
NONE IS AVAILABLE

218089  
Barium\*  
Magnesium

○  
CONSTITUENTS DETECTED ABOVE  
BACKGROUND IN THIS WELL

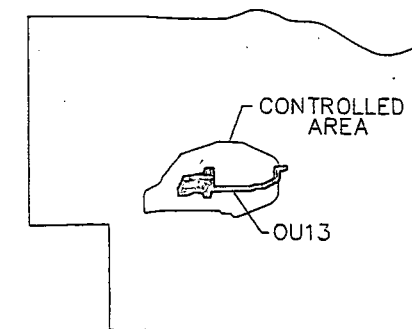
\* BOTH UPPER TOLERANCE LIMIT AND  
MAXIMUM BACKGROUND CONCEN-  
TRATIONS WERE EXCEEDED FOR THIS  
CONSTITUENT.

THE ABSENCE OF ONE OF THE  
ABOVE IDENTIFIERS SIGNIFIES  
THAT NO DATA WAS REQUESTED  
FOR THIS WELL

- ALLUVIAL WELL/PIEZOMETER
- ⊗ BEDROCK WELL
- ⬡ BOREHOLE
- △ PRE-1986 MONITOR WELL

SCALE

0 300 600



U.S. DEPARTMENT OF ENERGY  
Rocky Flats Plant  
Golden Colorado

OPERABLE UNIT NO. 13  
PHASE I RFI/RI WORK PLAN

FIGURE 2-44

Radionuclides Detected  
Above Background  
in Bedrock

0681

117.1

186

117.2

158

117.3

190

128 & 134(N)

171

134

191

148

157.1

152

114889  
Uranium 238

114789  
Uranium 235  
Uranium 238

214689  
Radium 226

115489  
Strontium 89,90  
Uranium 233,234  
Uranium 235  
Uranium 238

214089  
Strontium 89,90\*

213689  
Plutonium 239,240  
Radium 226\*  
Radium 228\*  
Tritium\*

313489  
Plutonium 239, 240  
Radium 226\*  
Radium 228\*  
Strontium 89,90\*  
Uranium 233,234  
Uranium 238



MAP LEGEND

171

INDIVIDUAL HAZARDOUS  
SUBSTANCE SITES

—

OU 13 BOUNDARY

NA

DATA REQUESTED BUT  
NONE IS AVAILABLE

218089  
Barium\*  
Magnesium

○  
CONSTITUENTS DETECTED ABOVE  
BACKGROUND IN THIS WELL

• BOTH UPPER TOLERANCE LIMIT AND  
MAXIMUM BACKGROUND CONCEN-  
TRATIONS WERE EXCEEDED FOR THIS  
CONSTITUENT.

THE ABSENCE OF ONE OF THE  
ABOVE IDENTIFIERS SIGNIFIES  
THAT NO DATA WAS REQUESTED  
FOR THIS WELL

○

ALLUVAL WELL/PIEZOMETER

⊕

BEDROCK WELL

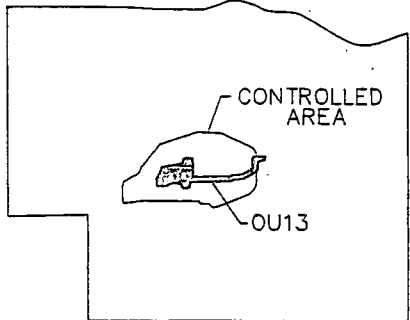
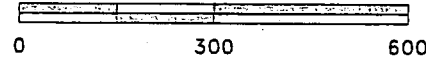
⬡

BOREHOLE

△

PRE-1986 MONITOR WELL

SCALE

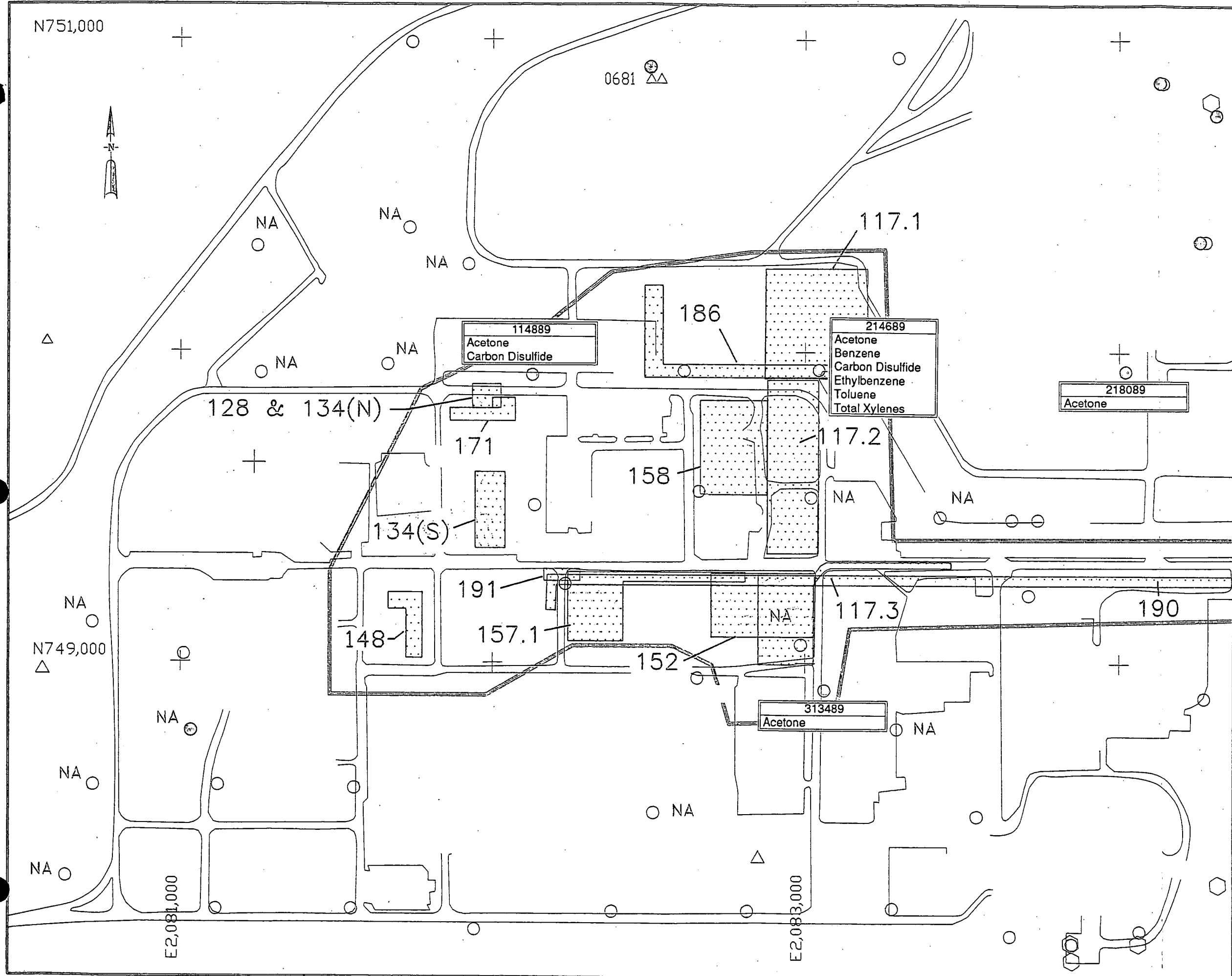


U.S. DEPARTMENT OF ENERGY  
Rocky Flats Plant  
Golden Colorado

OPERABLE UNIT NO. 13  
PHASE I RFI/RI WORK PLAN

FIGURE 2-45

VOC's Detected  
Above Background  
in Bedrock



N751,000

OU132-46.DWG

MAP LEGEND

171

INDIVIDUAL HAZARDOUS  
SUBSTANCE SITES

OU 13 BOUNDARY

NA

DATA REQUESTED BUT  
NONE IS AVAILABLE

218089  
Barium\*  
Magnesium

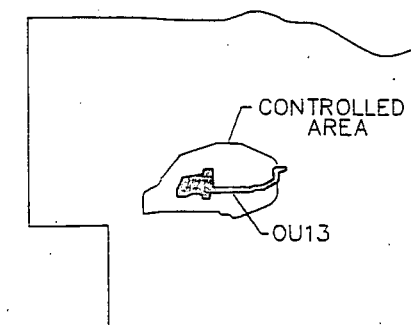
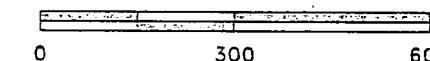
CONSTITUENTS DETECTED ABOVE  
BACKGROUND IN THIS WELL

\* BOTH UPPER TOLERANCE LIMIT AND  
MAXIMUM BACKGROUND CONCEN-  
TRATIONS WERE EXCEEDED FOR THIS  
CONSTITUENT.

THE ABSENCE OF ONE OF THE  
ABOVE IDENTIFIERS SIGNIFIES  
THAT NO DATA WAS REQUESTED  
FOR THIS WELL

- ALLUVIAL WELL/PIEZOMETER
- ⊗ BEDROCK WELL
- ⬡ BOREHOLE
- △ PRE-1986 MONITOR WELL

SCALE



U.S. DEPARTMENT OF ENERGY  
Rocky Flats Plant  
Golden Colorado

OPERABLE UNIT NO. 13  
PHASE I RFI/RI WORK PLAN

FIGURE 2-46

Metals Detected  
Above Background  
in Bedrock

0681

117.1

186

117.2

158

117.3

190

128 & 134(N)

171

134(S)

191

157.1

152

E2,081,000

E2,083,000

NA

N749,000

NA

NA

NA

114889  
Aluminum  
Arsenic  
Copper  
Iron  
Magnesium  
Potassium  
Vanadium\*

214689  
Barium  
Copper  
Iron

114789  
Copper\*  
Iron  
Nickel  
Vanadium\*  
Zinc

115489  
Arsenic  
Copper  
Lead

218089  
Barium\*  
Magnesium

214089  
Arsenic  
Barium\*  
Calcium  
Magnesium  
Zinc

213689  
Copper  
Lead  
Zinc

313489  
Arsenic  
Barium  
Copper  
Lead  
Manganese  
Potassium



N751,000

0681

OU132-47.DWG

## MAP LEGEND

171

INDIVIDUAL HAZARDOUS  
SUBSTANCE SITES

—

OU 13 BOUNDARY

NA

DATA REQUESTED BUT  
NONE IS AVAILABLE218089  
Barium\*  
Magnesium○  
CONSTITUENTS DETECTED ABOVE  
BACKGROUND IN THIS WELL• BOTH UPPER TOLERANCE LIMIT AND  
MAXIMUM BACKGROUND CONCENTRATIONS  
WERE EXCEEDED FOR THIS  
CONSTITUENT.THE ABSENCE OF ONE OF THE  
ABOVE IDENTIFIERS SIGNIFIES  
THAT NO DATA WAS REQUESTED  
FOR THIS WELL

- ALLUVIAL WELL/PIEZOMETER
- ⊗ BEDROCK WELL
- ⬡ BOREHOLE
- △ PRE-1986 MONITOR WELL

SCALE

0 300 600

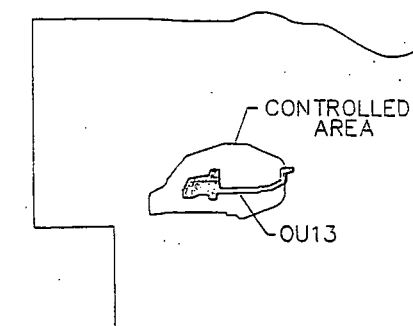
U.S. DEPARTMENT OF ENERGY  
Rocky Flats Plant  
Golden, ColoradoOPERABLE UNIT NO. 13  
PHASE I RFI/RI WORK PLAN

FIGURE 2-47

Radionuclides Detected  
Above Background  
in Surficial Materials

128 &amp; 134(N)

134(S)

NA  
N749,000  
△

NA

NA

NA

E2,081,000

E2,083,000

114889  
Plutonium 239,240  
Radium 226\*  
Radium 228\*  
Uranium 233,234  
Uranium 238114789  
Plutonium 239,240\*  
Radium 226\*  
Strontium 89,90\*  
Uranium 233,234  
Uranium 235\*  
Uranium 238115489  
Gross Beta\*  
Plutonium 239,240\*  
Radium 226\*  
Radium 228  
Strontium 89,90\*  
Tritium\*  
Uranium 233,234  
Uranium 235  
Uranium 238115589  
Plutonium 239,240\*  
Radium 226\*  
Radium 228  
Strontium 89,90\*  
Uranium 233,234  
Uranium 235\*  
Uranium 238418289  
Plutonium 239,240\*  
Radium 226  
Radium 228  
Uranium 238313489  
Gross Beta\*  
Plutonium 239,240\*  
Radium 226\*  
Strontium 89,90\*  
Uranium 233,234  
Uranium 235  
Uranium 238214689  
Gross Beta  
Plutonium 239,240  
Radium 226\*  
Radium 228  
Strontium 89,90\*  
Uranium 233,234  
Uranium 238214089  
Strontium 89,90\*213689  
Cesium\*  
Gross Beta\*  
Plutonium 239,240\*  
Radium 226\*  
Radium 228  
Strontium 89,90  
Tritium\*  
Uranium 233,234  
Uranium 235\*  
Uranium 238

117.1

186

158

117.2

117.3

190

191

157.1

152

N751,000

OU132-48.DWG

## MAP LEGEND

171

INDIVIDUAL HAZARDOUS  
SUBSTANCE SITES

—

OU 13 BOUNDARY

NA

DATA REQUESTED BUT  
NONE IS AVAILABLE218089  
Barium\*  
MagnesiumCONSTITUENTS DETECTED ABOVE  
BACKGROUND IN THIS WELL• BOTH UPPER TOLERANCE LIMIT AND  
MAXIMUM BACKGROUND CON-  
CENTRATIONS WERE EXCEEDED FOR THIS  
CONSTITUENT.THE ABSENCE OF ONE OF THE  
ABOVE IDENTIFIERS SIGNIFIES  
THAT NO DATA WAS REQUESTED  
FOR THIS WELL

- ALLUVIAL WELL/PIEZOMETER
- ⊙ BEDROCK WELL
- ⬡ BOREHOLE
- △ PRE-1986 MONITOR WELL

SCALE

0 300 600

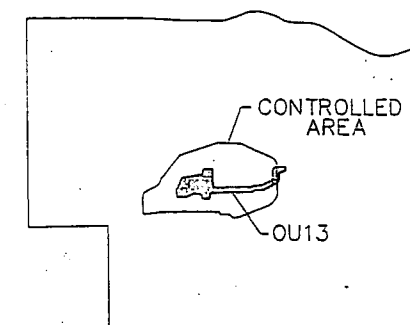
U.S. DEPARTMENT OF ENERGY  
Rocky Flats Plant  
Golden ColoradoOPERABLE UNIT NO. 13  
PHASE I RFI/RI WORK PLAN

FIGURE 2-48

VOC's Detected  
Above Background  
in Surficial Materials

0681

117.1

114789

Acetone  
Benzene  
Carbon Disulfide  
Ethylbenzene  
Toluene  
Total Xylenes

186

214689

Acetone  
Benzene  
Carbon Disulfide  
Ethylbenzene  
Toluene  
Total Xylenes

218089

Acetone

128 &amp; 134(N)

171

158

17.2

134(S)

115489

Acetone  
Methylene Chloride  
Toluene

115589

1,1-Dichloroethane  
1,1-Dichloroethene  
1,2-Dichloroethene  
1,1,1-Trichloroethane  
1,1,2,2-Trichloroethane  
Acetone  
Tetrachloroethene

213689

2-Butanone  
Acetone  
Methylene Chloride  
Total Xylenes

190

117.3

191

157.1

152

418289

Acetone

313489

1,1,1-Trichloroethane  
Acetone  
Methylene Chloride  
Zinc

NA

N749,000

NA

NA

NA

E2,081,000

E2,083,000

N751,000

OU132-49.DWG

MAP LEGEND

171

INDIVIDUAL HAZARDOUS  
SUBSTANCE SITES

OU 13 BOUNDARY

NA

DATA REQUESTED BUT  
NONE IS AVAILABLE

218089  
Barium\*  
Magnesium

○  
CONSTITUENTS DETECTED ABOVE  
BACKGROUND IN THIS WELL

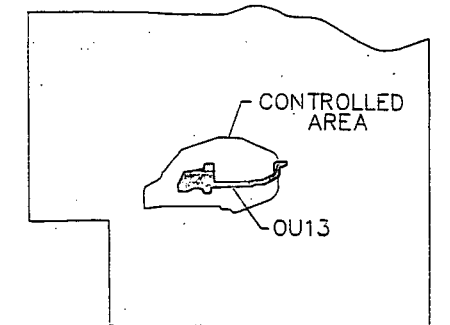
\* BOTH UPPER TOLERANCE LIMIT AND  
MAXIMUM BACKGROUND CONCEN-  
TRATIONS WERE EXCEEDED FOR THIS  
CONSTITUENT.

THE ABSENCE OF ONE OF THE  
ABOVE IDENTIFIERS SIGNIFIES  
THAT NO DATA WAS REQUESTED  
FOR THIS WELL

○ ALLUVIAL WELL/PIEZOMETER  
⊕ BEDROCK WELL  
⬡ BOREHOLE  
△ PRE-1986 MONITOR WELL

SCALE

0 300 600



U.S. DEPARTMENT OF ENERGY  
Rocky Flats Plant  
Golden, Colorado

OPERABLE UNIT NO. 13  
PHASE I RFI/RI WORK PLAN

FIGURE 2-49

Metals Detected  
Above Background  
in Surficial Materials

0681

117.1

186

214689

Barium  
Cadmium  
Copper\*  
Iron  
Manganese  
Potassium  
Sodium\*  
Vanadium  
Zinc

114789

Arsenic  
Barium  
Copper\*  
Iron  
Manganese  
Vanadium

117.2

115589

Arsenic  
Copper  
Manganese  
Potassium  
Vanadium\*  
Zinc

NA

NA

214089

Aluminum\*  
Antimony  
Arsenic  
Barium  
Copper\*  
Iron\*  
Lead  
Magnesium  
Manganese  
Nickel  
Potassium  
Vanadium  
Zinc\*

213689

Aluminum  
Barium  
Cadmium\*  
Calcium  
Chromium\*  
Copper  
Iron  
Lead\*  
Magnesium  
Mercury\*  
Potassium  
Vanadium  
Zinc\*

190

117.3

152

418289

Calcium  
Cesium  
Copper  
Lead  
Manganese\*  
Potassium  
Vanadium

313489

Arsenic  
Barium\*  
Calcium  
Chromium  
Copper  
Iron  
Magnesium  
Manganese  
Potassium

NA

NA

128 & 134(N)

171

114889

Aluminum  
Arsenic  
Copper  
Iron  
Magnesium\*  
Vanadium  
Zinc

134(S)

115489

Aluminum  
Arsenic  
Barium  
Calcium  
Copper\*  
Iron  
Lead  
Magnesium\*  
Vanadium\*  
Zinc

148

191

NA

N749,000

NA

NA

NA

E2,081,000

E2,083,000

N751,000

0681

OU132-50.DWG

## MAP LEGEND

171

INDIVIDUAL HAZARDOUS  
SUBSTANCE SITES

OU 13 BOUNDARY

NA

DATA REQUESTED BUT  
NONE IS AVAILABLE218089  
Barium\*  
MagnesiumCONSTITUENTS DETECTED ABOVE  
BACKGROUND IN THIS WELL

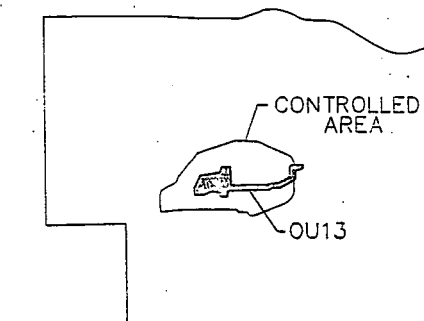
• BOTH UPPER TOLERANCE LIMIT AND  
MAXIMUM BACKGROUND CON-  
CENTRATIONS WERE EXCEEDED FOR THIS  
CONSTITUENT.

THE ABSENCE OF ONE OF THE  
ABOVE IDENTIFIERS SIGNIFIES  
THAT NO DATA WAS REQUESTED  
FOR THIS WELL

- ALLUVIAL WELL/PIEZOMETER
- ⊙ BEDROCK WELL
- ⬡ BOREHOLE
- △ PRE-1986 MONITOR WELL

SCALE

0 300 600



U.S. DEPARTMENT OF ENERGY  
Rocky Flats Plant  
Golden Colorado

OPERABLE UNIT NO. 13  
PHASE I RFI/RI WORK PLAN

FIGURE 2-50

Radionuclides Detected  
Above Background  
in Groundwater

128 &amp; 134(N)

171

186

117.1

158

117.2

134(S)

4486  
Gross Beta  
Strontium 89,90  
Tritium\*  
Uranium 233,234\*  
Uranium 238\*

191

157.1

152

418289  
Strontium 89,90  
Uranium 233,234\*  
Uranium 238\*

117.3

6186

Cesium\*  
Strontium 89,90  
Uranium 233,234\*  
Uranium 238\*

190

NA

N749,000

NA

NA

NA

E2,081,000

E2,083,000

MAP LEGEND

171

INDIVIDUAL HAZARDOUS  
SUBSTANCE SITES

NA

OU 13 BOUNDARY

NA

DATA REQUESTED BUT  
NONE IS AVAILABLE

218089  
Barium\*  
Magnesium

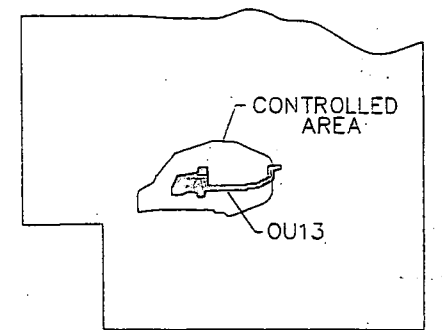
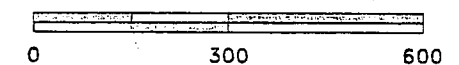
○  
CONSTITUENTS DETECTED ABOVE  
BACKGROUND IN THIS WELL

\* BOTH UPPER TOLERANCE LIMIT AND  
MAXIMUM BACKGROUND CONCENTRATIONS  
WERE EXCEEDED FOR THIS  
CONSTITUENT.

THE ABSENCE OF ONE OF THE  
ABOVE IDENTIFIERS SIGNIFIES  
THAT NO DATA WAS REQUESTED  
FOR THIS WELL

- ALLUVIAL WELL/PIEZOMETER
- ⊗ BEDROCK WELL
- ⬡ BOREHOLE
- △ PRE-1986 MONITOR WELL

SCALE

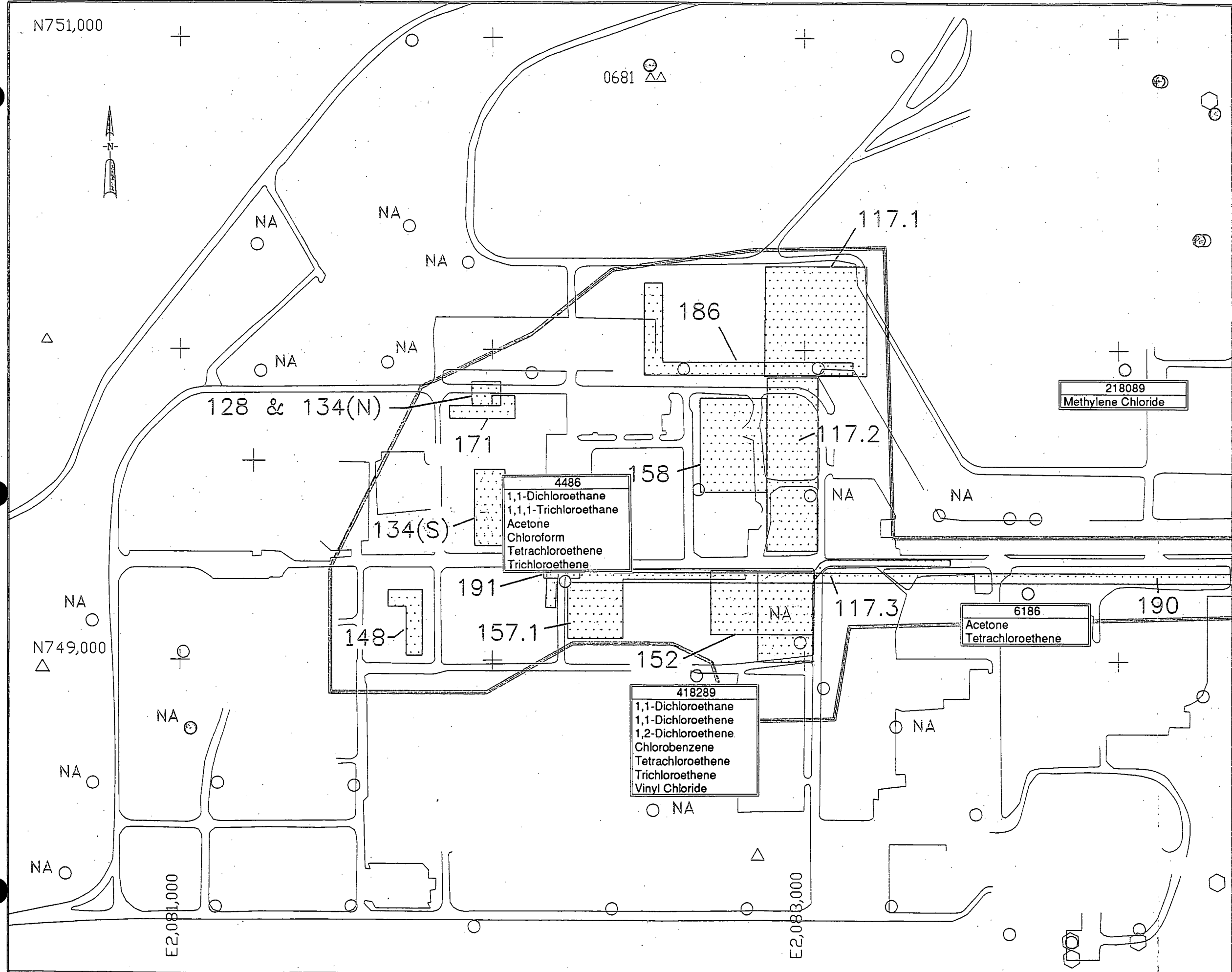


U.S. DEPARTMENT OF ENERGY  
Rocky Flats Plant  
Golden Colorado

OPERABLE UNIT NO. 13  
PHASE I RFI/RI WORK PLAN

FIGURE 2-51

VOC's Detected  
Above Background  
in Groundwater



N751,000

OU132-52.DWG

MAP LEGEND

171

INDIVIDUAL HAZARDOUS  
SUBSTANCE SITES

—

OU 13 BOUNDARY

NA

DATA REQUESTED BUT  
NONE IS AVAILABLE

218089  
Barium\*  
Magnesium

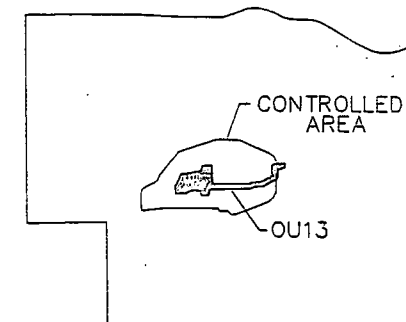
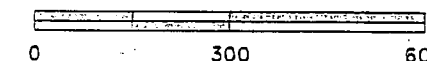
○  
CONSTITUENTS DETECTED ABOVE  
BACKGROUND IN THIS WELL

• BOTH UPPER TOLERANCE LIMIT AND  
MAXIMUM BACKGROUND CONCEN-  
TRATIONS WERE EXCEEDED FOR THIS  
CONSTITUENT.

THE ABSENCE OF ONE OF THE  
ABOVE IDENTIFIERS SIGNIFIES  
THAT NO DATA WAS REQUESTED  
FOR THIS WELL

- ALLUVAL WELL/PIEZOMETER
- ⊙ BEDROCK WELL
- ⬡ BOREHOLE
- △ PRE-1986 MONITOR WELL

SCALE



U.S. DEPARTMENT OF ENERGY  
Rocky Flats Plant  
Golden Colorado

OPERABLE UNIT NO. 13  
PHASE I RFI/RI WORK PLAN

FIGURE 2-52

Metals Detected  
Above Background  
in Groundwater

0681

117.1

186

128 & 134(N)

171

158

117.2

134(S)

4486

Barium\*  
Calcium\*  
Chromium\*  
Magnesium\*  
Mercury\*  
Sodium\*

191

157.1

152

418289

Barium\*  
Calcium\*  
Chromium\*  
Magnesium\*  
Mercury\*  
Sodium\*

117.3

6186

Calcium\*  
Chromium\*  
Lead\*  
Magnesium\*  
Sodium

190

NA

N749,000

NA

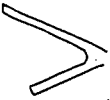
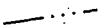


NA

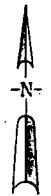
NA

E2,081,000

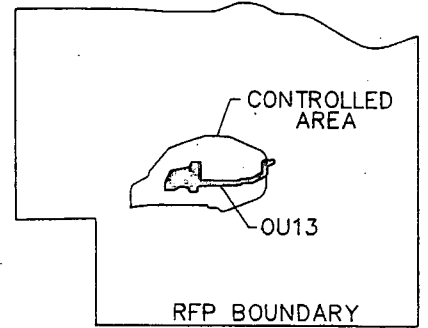
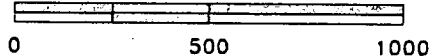
E2,083,000

LEGEND

-  PAVED ROADS
-  WATER
-  SITE LOCATIONS
-  OPERABLE UNIT 13



SCALE

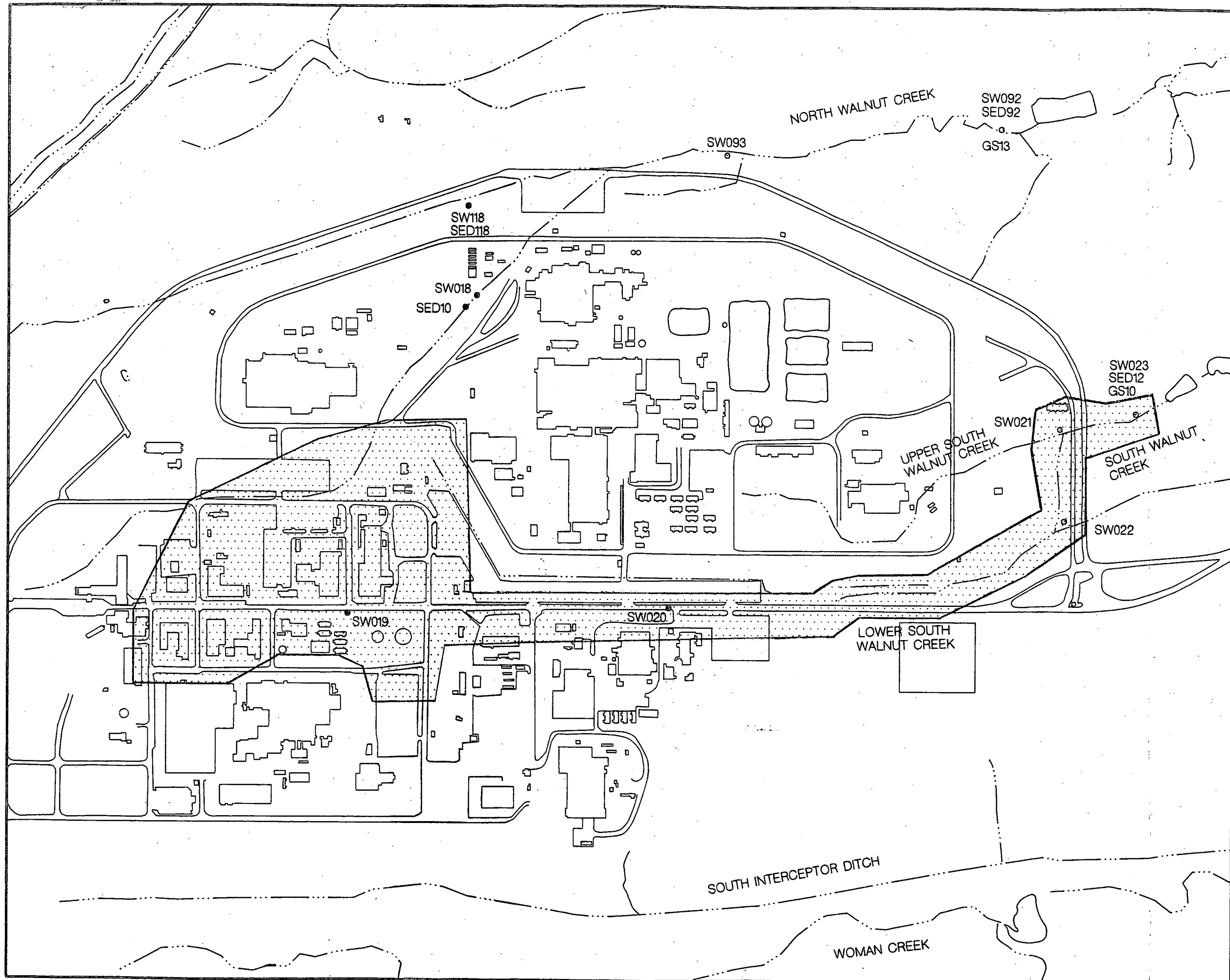


U.S. DEPARTMENT OF ENERGY  
Rocky Flats Plant  
Golden Colorado

OPERABLE UNIT NO. 13  
PHASE I RFI/RI WORK PLAN

FIGURE 2-53

**SURFACE WATER MONITORING  
SITE LOCATION MAP**

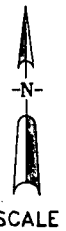


LEGEND

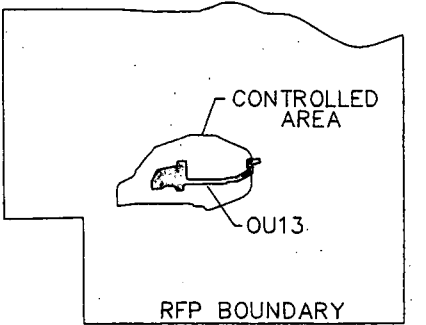
INDIVIDUAL HAZARDOUS SUBSTANCE SITES  
TO WHICH GROUNDWATER DATA  
MAY BE APPLICABLE

a	117.1	g	148
b	117.2	h	152
c	117.3	i	157.1
d	122	j	158
e	128	k	171
f	134	l	186

- 191  
INDIVIDUAL HAZARDOUS  
SUBSTANCE SITES
- OPERABLE UNIT 13
- 4486  
EXISTING WELL OR PIEZOMETER  
TO BE SAMPLED DURING STAGE 1



0 200 400



U.S. DEPARTMENT OF ENERGY  
Rocky Flats Plant  
Golden Colorado

OPERABLE UNIT NO. 13  
PHASE I RFI/RI WORK PLAN

FIGURE 6-2

STAGE 1  
EXISTING GROUNDWATER MONITORING  
WELLS AND PIEZOMETERS TO BE SAMPLED

